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Some Researches and Inventions

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SOME RESEARCHES AND INVENTIONS IN HYDRAULIC, ELECTRICAL, AND MOTOR VEHICLE ENGINEERING.

As a Candidate for the Degree of D.Sc. in Engineering, I beg to present the following thesis, which I submit as a record of a considerable amount of research work undertaken by me since my graduation as a Bachelor of Science in Engineering at Edinburgh University, 1890, and in the course of which researches various inventions in the realm of hydraulic, electrical, and principally motor car engineering, have been devised by me, and are the subject matter of the Patent Specifications appended to this thesis. As many of these inventions have had a wide and successful application in their particular field, and have, therefore, proved successful in practice, they may be termed engineering work of importance.

The first patent in the series, No. 22351/91, No. 1 in schedule, describes a governor for controlling the speed of hydraulic turbines. Early in 1890 I was entrusted with the design of a water-power electric light installation, in which it was particularly desired to avoid the use of accumulators and to run direct at all times. Not anticipating serious difficulties I decided to put down a 5·5 B.H.P. Vortex turbine coupled direct to a compound-wound continuous current dynamo, so arranged that if the speed were kept constant from no load to full load, the E.M.F. at the point of supply would be constant, the dynamo being slightly over compounded to compensate for loss of E.M.F. in the main conductors.

Upon the turbine shaft was mounted a Proell centrifugal governor, the sliding cuff of which was linked to an ordinary four-way piston slide valve fed with water from the main, and coupled up to a double-acting hydraulic cylinder, which in turn operated the gates of the turbine, the general arrangement being similar to that shown in Fig. 7 of said patent. When the speed rose above normal the governor moved the piston valve from the neutral position and admitted water under pressure to that side of the piston in the hydraulic cylinder, which tended to close the turbine gates, the piston valve at the same time opening the other side of the cylinder to exhaust until the speed became once again normal, when the governor brought the piston valve back to neutral position. When the speed fell below normal, water was admitted to the cylinder in such a manner as to open the turbine gates until normal speed was again attained.

The piston valve was of the ordinary design, as used in double-acting steam engine work, the length of the piston itself being about 2½ diameters long with a very ample annular groove in the centre of it, the pistons at each end being designed with a slight lap over all the ports in neutral position. The first trial runs proved the device a failure. The turbine went far beyond normal speed before the governor could check it, and then fell far below normal before the governor reacted—in other words, excessive " hunting " took place. Sometimes the amplitude of the excursions gradually died out, and ultimately stability was reached at something approaching normal speed, but at other times the oscillations continued indefinitely. Any appreciable alteration of load on the dynamo was apt to set up a series of these speed variations. Clearly the matter called for the fullest

consideration and investigation, and a complete remodelling of the scheme. A few preliminary tests were made, and the difficulties analysed, and the following points brought to light:—

First, as we were dealing with an incompressible fluid, we had to take account of the momentum of the whole mass of water in the piping from the dam to the turbine.

Second, we dare not attempt to check this momentum too rapidly, or the corresponding increase of pressure at the turbine would cause the governor to close the gates beyond the position necessary for that speed and load under stable conditions, and when this excess pressure subsided the speed would consequently fall below normal and the reaction set in. Conversely, we must not open up the gates too rapidly, or a corresponding trouble would arise through the governor opening up the gates too far.

Third, the friction losses in the governor must be reduced to a minimum and the governor must possess a reasonable amount of stability. The Proell governor was designed to be isochronous, but it had considerable friction losses, with the result that it did not operate until the speed had risen appreciably over normal, and then the balls travelled out almost instantaneously to the extreme position. The falling characteristic of this governor was equally unsatisfactory.

Fourth, the reaction from the piston valve must be reduced to a minimum. The ordinary piston valve proved extremely defective in this respect; it took a considerable force to move it from the neutral position, and the moment it was slightly opened in either direction it gave a violent reaction on the operating mechanism and would have required a powerful governor indeed to operate it with any approach to accuracy.

An investigation of the first two of these points was first of all undertaken. The pipe supplying the turbine was of cast iron, 7″ bore, 600 yards long, with a fall from the dam to the turbine of 103 feet, corresponding to a pressure of 44·4 lbs. per square inch $=p_1$. The turbine gave 5·5 B.H.P. with 40 cubic feet per minute. This corresponds to a velocity in the pipes of 2·5 feet per second. If, therefore, the gates of the turbine were moved from full open to shut in time t in seconds, the average increase in pressure in lbs. per square inch due to the momentum would be p.

$$\text{where } p=\frac{w\,l\,v}{g\,t}$$

where w = weight of cubic inch of water.

l = length of pipe in inches.

v = velocity in feet per second.

when $t=2$ seconds let $p=p_2$.

$$\text{then } p_2=\frac{\cdot0361\times600\times36\times2\cdot5}{32\cdot2\times2}=30\cdot3 \text{ lbs. per sq. inch.}$$

For the moment we may neglect the loss of head due to friction in the pipes, which of course varies as the square of the speed, as its maximum value in the present instance is under 2·5 lbs. per square inch.

If the turbine were to be cut down from full quantity to half quantity in one second, that is checking the momentum at the same rate as above, then the working pressure at that moment would be approximately $p_1+p_2=p_3=44+30=74$ lbs. per square inch, or an increase of 68 per cent.. above normal. Now, for any given opening of the gates the flow through the turbine is $Q=v\Delta=C_1\sqrt{p}$, and assuming constant efficiency in the turbine

$$\begin{aligned}\text{the B.H.P.} &= C_2\times Q\times p\\ &= C_2\times C_1\times\sqrt{p}\times p\\ &= C_2\times C_1\times p^{\frac{3}{2}}\end{aligned}$$

The B.H.P. of the turbine would, therefore, momentarily rise in the ratio

$$\frac{p_2^{\frac{3}{2}}}{p_1^{\frac{3}{2}}} = \frac{2013}{923} = \frac{2{\cdot}18}{1}$$

obviously a serious question, as it would lead the governor to close the gates far beyond the proper position for stable conditions, and reaction would occur as soon as the temporary increase of pressure subsided. Obviously, therefore, the rate of opening or closing the gates must not exceed such a rate as will not cause a serious decrease or increase of main pressure.

Dealing with the third point, after due consideration a Pickering type of governor was chosen, as it appeared to be most free from error due to internal friction. The centrifugal weights are attached to the centre of flat steel springs, which in turn are attached at either extremity to discs rotating on the governor spindle, one being fixed and the other free to slide, the action of the governor as the speed rises being to bend the flat steel springs to a reflex curve and to cause the discs to approach each other. The motion of the sliding disc is transferred in the usual manner to the slide valve. This governor required a rise of speed of about 6 per cent. to travel its complete range, but the friction losses were so small as to be practically negligible.

Dealing with the fourth point proved to be a much more difficult question. The disturbing reactions on the spindle of this valve were probably due partly to axial flow in the annual portion of the piston of the valve which, as in steam engine practice, was of considerable length, and partly also due to the high velocity of flow both of the water entering the inlet ports to the one end of the hydraulic cylinder and the corresponding exhaust flow from the opposite end, both of which reactions on the valve spindle were in the same direction. Bearing these points in view, it was decided to design a valve in which there would be no axial flow, but in which all flow would be normal to the axis of the piston, and therefore could have no reactive effect. Also, it was decided to keep the passage in the piston of the slide valve as small as possible, so that at any point of it there would be practically uniform flow, and any reactions due to decrease of pressure resultant from the velocity of flow would be balanced. To eliminate reactions at the exhaust ports the valve was constructed so that in the neutral position both ends of the hydraulic cylinder were slightly open to exhaust. On the supply side the valve had a slight lap over the ports leading to the top and bottom of the hydraulic cylinder.

The actual design of the valve is clearly shown in the drawing attached to the patent specification, and a detailed description of the valve is also given. The earlier valves were constructed exactly in accordance with this drawing, and were most successful. A slight reaction could still be felt, but was so small as to be negligible. In subsequent valves certain modifications of dimensions were introduced which still further increased the efficiency of the device.

One interesting modification may be mentioned.

In an electric lighting plant, if the major portion of the load is suddenly thrown off, unless the turbine gates are checked very promptly the speed, and, therefore, the E.M.F., may rise so high as to damage the lamps, and in some instances it has been necessary to make the closing of the gates sufficiently rapid to avoid this danger. It would not be possible to govern the turbine, for the reasons aforementioned, if the rate of opening of the gates were equally rapid, but there is obviously no objection to keeping the rate of the opening of the gates within the limits necessary for stability, as it only means a temporary drop in the luminosity of the lamps.

Referring to Fig. VII., as explained in the Specification No. 1 in schedule, when the piston " V " moves downward in the cylinder K, it opens up the turbine gates,

and, conversely, when it moves upwards it reduces the supply of water to the turbine. To give the action of the governor the characteristic indicated in the previous paragraph, a self-acting check valve was inserted in the pipe T. This valve allowed the water to flow freely from the cylinder K to the valve A, and in parallel with this valve was an adjustable by-pass which could be throttled down to any desired extent. Seeing, therefore, that there was no check in the pipe B, the closing of the gates may be as rapid as the dimensions of the mechanism and the available pressure permitted, as the check valve in T permitted a free exhaust from the upper side of the cylinder K through the valve A. The opening up of the gates, however, was determined by the adjustment of the by-pass valve on T, and could be readily adjusted to keep just within stable limits.

In some instances the centrifugal governor has been replaced by a solenoid, which may be very conveniently directly connected to any distant point of the electric supply system, and thereby maintain a constant E.M.F. at that point irrespective of the loss in the mains or the characteristic of the dynamo.

I took a set of tests some 20 years ago of a 20 hp. turbine electric lighting plant fitted with my governor and solenoid control. Some 30 readings were taken, varying from 2 amperes to 119 amperes, and throughout the range the maximum variation of voltage was 2·5 per cent. A test of a similar plant, but having a Pickering governor control, showed the speed variation within 2 per cent. from no load to full load.

Turbine governors constructed under this patent have been most successfully applied on water power installations all over the world. As a notable instance, there may be mentioned the hydraulic electric generating station for the lighting of the town of Launceston, Tasmania, in which a group of eight turbines is installed, each controlled by a Murray patent governor. I think my device may be claimed to be the first satisfactory solution of the somewhat difficult problem of governing hydraulic turbines.

One of the next researches undertaken by me was the design of motors for electrically-propelled road vehicles. While in motor road vehicles propelled by internal-combustion engines it has almost invariably been the practice to introduce between the engine and the road wheels some type of gear-box providing the means of varying the angular velocity ratio between the engine and the road wheels, in electrical vehicles one naturally prefers to design the motor in such a way that it is possible to connect it with the road wheels through a gear having a fixed ratio. The tractive effort for such a vehicle on a level macadam road is, of course, variable within wide limits, but may be taken for the moment at 70 lbs. per ton. If we assume that the maximum gradient which the vehicle has to negotiate is 1 in 6, the additional tractive effort per ton will be 373 lbs. Adding this to the road resistance of 70 lbs. gives us a total of 413 lbs. per ton. For similar speeds, therefore, the torque required from the motor for extreme hills will be practically six times as great as that required on a level road. It may further be assumed tha the vehicle should be capable of any speed up to 25 miles per hour on gradients not exceeding 1 in 20, which latter gradient would call for a tractive effort of about 180 lbs. per ton. After a preliminary investigation it was decided to use a motor having two armatures mounted on the same shaft with separate but similar windings, and to adopt a series-parallel control.

The required duty of the motor was tabulated for various conditions, and then the dimensions were determined in accordance with the accepted rules for the design of continuous-current motors. It became abundantly clear that to secure the necessary flexibility to enable the motor to comply with the widely varying conditions as above indicated, it would be necessary to vary the strength of the main magnetic field to a considerable extent to obtain suitable speeds and torques for all conditions. For work of this kind obviously the motor must be designed to run satisfactorily, i.e.,

sparklessly under all conditions ahead or astern with fixed brush position, and this in conjunction with the varying of the main magnetic field made the question of sparkless commutation a very real difficulty.

Having paid particular attention to the work done by Mr. W. B. Sayers on this question of sparkless commutation, it occurred to me that the proper thing to do in this case was to provide a separate and distinct magnetic reversing field in the zone of commutation. The design of machine is described in Patent Specification 23418/97 (No 2 in schedule herewith). Drawings of three actual machines designed and constructed in accordance with the above specification are shown on Figs. Nos. 7, 8, 9, 10, 11, 12, and 13.

Fig. 7 shows a side elevation and a sectional elevation of a two-pole motor, and Fig. 8 the end view of the same. The actual arrangement and method of carrying the reversing poles G and F is apparent from these drawings. Fig. 10 shows an end view of a four-pole motor, Fig. 11 a cross-section of the same, and Fig. 9 a sectional longitudinal elevation, showing also the brake drum and the worm drive to the differential and cross shafts of the vehicle. F and G represent in this case also the reversing poles.

Fig. 12 shows a sectional elevation of an eight-pole motor, and Fig. 13 an end view and cross-section of the same. In every case the armatures were series wound, so that only one magnetic circuit or system per armature core was necessary for the reversing field, and one pair of brushes. For any given speed the magneto motive force required for the reversing field is approximately proportionate to the armature current, so the simple expedient in the case of the two- and four-pole motors was adopted of coupling the winding of one reversing pole permanently in series with the one armature winding, and the other permanently in series with the other. The first tests of these motors disclosed the fact that the preliminary calculation for the strength of the reversal field had made more than ample allowance, and that the magneto motive force could be considerably reduced on the commutating field and still ensure sparkless commutation at all loads and speeds, either ahead or astern. In the design of later motors much helpful information was found in the very able articles of Professor Arnold and Dr. Mie, appearing in the "Elektrotechnische Zeitschrift." My first calculation brought out the maximum necessary for the reversing field in the air gap at 2,000 C.G.S. lines per square centimetre. As I have indicated above, this was found to be more than ample, and was subsequently considerably reduced. It is interesting to note that Arnold and Mie, in their summary, put the reversing field for armature coils having a high self-induction at not less than 680 C.G.S. lines per square centimetre. From the behaviour of the two- and four-pole motors on the test bed and on the road, I evolved the design shown on Figs. 12 and 13.

In the first place we have necessarily a considerable speed ratio between the armature spindle and the road wheel axle, and one point, therefore, is to keep the angular velocity of the armature as low as possible. To economise in weight of armature core iron, the number of magnetic cycles per second must be kept as high as possible, and the length of magnetic circuits a minimum, it was therefore decided to employ a motor having as large a number of poles as possible. The field magnets of this motor are formed of cast steel in two halves, F1 and F2 having inward projecting poles K1 to K9 alternately from either side of the ring, and energised by a common field winding group N. These poles are 36° apart, and, therefore, this would naturally be a ten-pole design, but one pole is entirely omitted, and the poles on either side of this gap—namely, K1 and K9—are cut down each to one-half. This arrangement is adopted to provide accommodation for the commutating field magnet system. The armature is of the slotted drum-wound type, having two superimposed independent windings in the same slots connected respectively to the commutators E1 and E2. The armature is series wound, as for a ten-pole field. The reversing

magnet L, with its coils M1 and M2, is so arranged that the centre lines of its poles are 18° on each side of the vertical. The winding is in two halves, one half being permanently connected in series with armature winding No. 1, and the other with armature winding No. 2, which arrangement gives substantially the same results as that described in the earlier motor.

The motor was totally enclosed by aluminium alloy covers, which also carried the bearings and the attachment faces for fixing to the frame of the vehicle. It will be noticed that the bearings are exceptionally long, and still the design is compact, and the complete motor was very light for its output. Some apprehension was felt that difficulty might be experienced in the commutation of the inner armature winding in view of the greater self-induction per coil as compared with the outer winding, but fears in this respect turned out to be groundless. Unfortunately, owing to the fact that it was found impossible to get secondary batteries of sufficiently robust construction to make the commercial success of these vehicles at all possible, the whole design had to be abandoned. Since that date some progress has been made in secondary battery construction, and it is hoped that at some not very distant date motors of the latter design at any rate may be constructed in large quantities for the propulsion of road vehicles.

In connection with the design of internal-combustion engines for the propulsion of motor vehicles, not only is it desirable to have an engine capable of operating at any torque from zero to full torque at any desired speed, but, further, the engine should be entirely self-controlled at any given speed. In other words, the driver should have under his direct control a lever by which he can set the speed of the engine at any point within its range, and then be able to depend upon the engine maintaining that speed irrespective of the load without further attention until he sees fit to alter it. Realisation of this fact led to the design of the governor described in Specification No. 3 in schedule. The governor is of the centrifugal type, but so designed that it commences to operate at about the lowest speed at which the engine will run light, and does not reach the upper limit of its travel until the engine has attained the maximum speed at which it is intended to operate.

Referring to Fig. 1 in Specification 3, it will be seen that in the earlier governors, to get a sufficiently wide range the centrifugal pull of the balls at low speeds was taken by a light spring K, and at higher speeds by a stiffer spring L. The same illustration shows diagramatically the means taken to obtain a variable speed control of the engine. It consisted in introducing a variable link between the governor sleeve C4 and the throttle valve of the engine H1. The effect of this variable link was simply to adjust the zero of the apparatus, or, in other words, to fix the point of the governor range at which the throttle valve closed, and so controlled the engine at or about the speed corresponding to this point of the governor travel.

The four figures in the patent specification indicate various mechanical methods of introducing the variable link. While each of these three methods, or modifications of them, were applied in types manufactured at various times, the method indicated in Fig. 2 was most widely applied. In it the floating link, or lever E, is controlled as to position at one end by the driver setting the lever G. The other end of E exactly follows the travel of the governor cuff. At or about the centre of it rests the spindle of the double-beat valve H1. The speed, therefore, at which the valve H closes can be adjusted to take place at any point of the governor travel. The speed travel characteristics (there being two separate characteristics in view of the two springs) of such a governor as is illustrated in Specification No. 3 are approximately of parabolic nature, whereas a straight line characteristic would be the ideal for the circumstances particularly when, as is

described later, the governor took control of the carburettor, and in some cases of the ignition advance). An attempt, therefore, was made to design a governor which, while being simple to manufacture and having only one spring, following Hooke's law, would approach this ideal. Several very successful solutions were obtained by various dispositions of the centrifugal weights, and arranging that their moment about the fulcrum pins decreased as the speed rose. Two of these governors are shown in Figs. 21 and 22. The measure of success attained is shown graphically in the governor characteristics H K, shown in Fig. 1. From

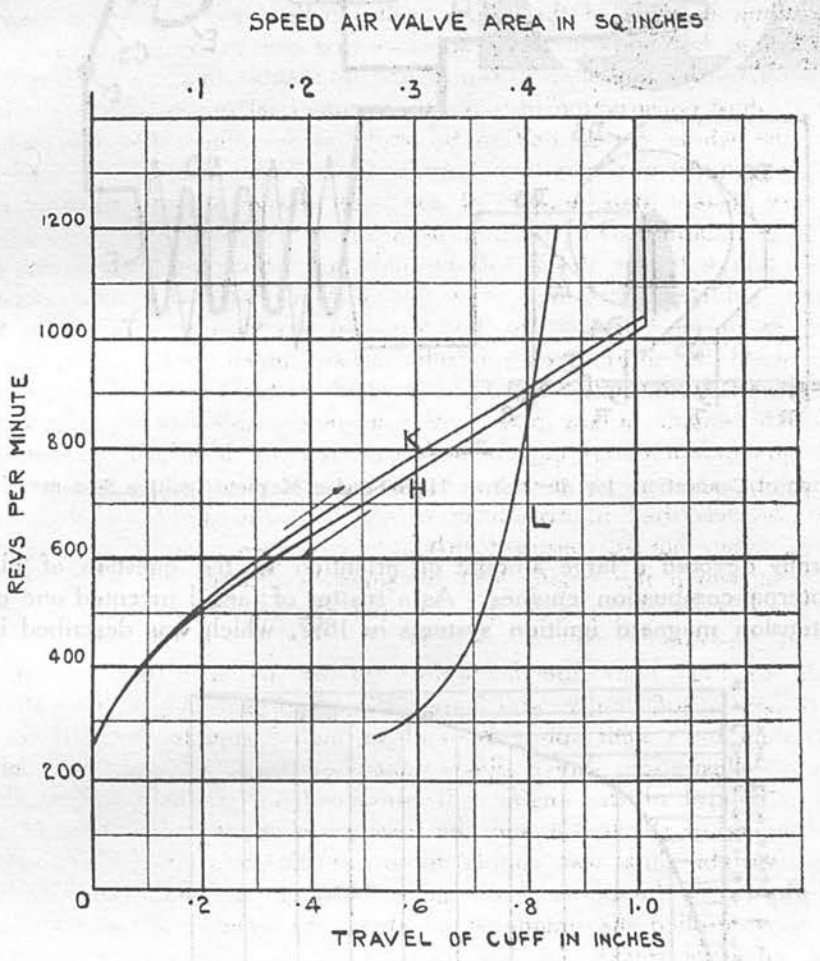


Fig. 1.

Governor Characteristic Curve.

a speed of about 420 R.P.M. up to 1,000 R.P.M. the characteristic is almost a straight line, which means that for equal increments of speed there were equal increments of travel of the governor cuff. The curve K is plotted from readings taken on a rising speed, the curve H from falling speeds. From this it will be seen that the friction losses in the governor were extremely small. At any given point of the governor travel the vertical ordinate between H and K shows the maximum speed error possible with this governor; in no case does it exceed 3 per cent.

Specification No. 37 in schedule describes an arrangement of governor mechanism entirely enclosed in the engine casing, so as to prevent any possibility of tampering by the driver.

Having spent a considerable portion of my career in electrical engineering

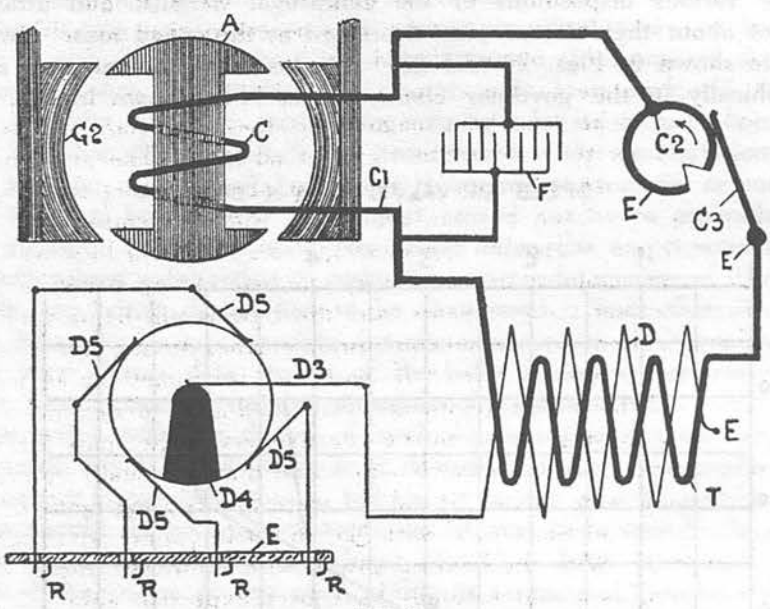


Fig. 2.

Diagram of Connections fort he Murray High-Tension Magneto Ignition System

work, I naturally devoted a large amount of attention to the question of electric ignition in internal-combustion engines. As a matter of fact, I invented one of the earliest high-tension magneto ignition systems in 1897, which was described in the

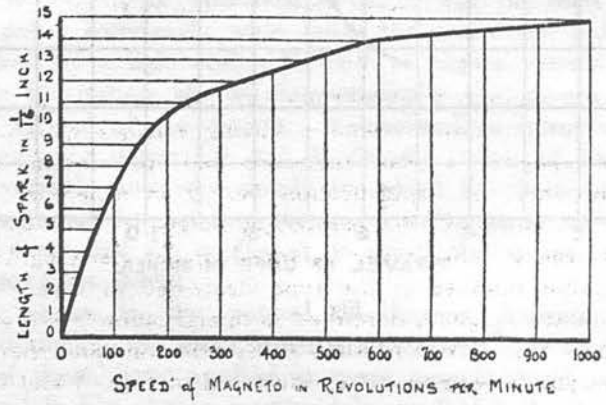


Fig. 3.

Diagram showing the Variation of Length of Spark obtained at various speeds with the Murray High-Tension Ignition.

" Automotor " journal in November, 1904, which article contained a description of my system, and the two illustrations shown in Figs. 2 and 3 hereof.

As may be seen from the curve of spark length, this apparatus gave excellent results, but at that date the difficulties of obtaining suitable insulating material for

high-tension work forced me to abandon the design, and adopt a low-tension system instead, with a make-and-break device operated mechanically within the combustion chamber of the motor. In order to produce an absolutely reliable magneto, and avoid the use of slip rings, brushes, or moving contacts, I decided to fix the armature and rotate the field magnets. As a magneto of the type employed generates an alternating current, it is necessary that the relative position of the field magnets and the armature should be such as to ensure a maximum spark at the time of rupture of the circuit (*i.e.*, of ignition of the charge). It was therefore decided to key the field magnets to the crankshaft of the engine, so that once correctly set they would be right for all time. The armatures of the early magnetos were of the Siemen's H type, but obviously that type is not very suitable for mounting in a fixed position concentric with the crankshaft. A very simple design of magneto shown in Specification No. 4 in schedule was evolved, and has proved most successful in practice, large numbers having been manufactured by my firm during the last thirteen years, and the type is still being turned out in considerable quantity fitted to internal-combustion engines driving road rollers where the severe vibration and arduous nature of the work call for something at once simple and robust in design. Exhaustive experiments were conducted to determine the best proportions of winding, having regard to the effectiveness of the spark and the freedom from burning of the contact points. It was found that an equally effective spark could be got throughout wide limits. It did not seem to affect the ignition efficiency of the spark whether the coil was wound with No. 16 S.W.G. copper wire, or with wire as fine as No. 32 S.W.G. With the heavier gauge wire, however, there was more burning of the contacts, as would naturally have been expected, although the effect was not serious. As a matter of fact, one armature wound with No. 14 wire was inadvertently fitted on a vehicle, but could never afterwards be traced, as no complaints came to light in connection with it. The actual standard winding adopted was 3,000 turns of No. 28 S.W.G.; the total magnetic flux through the armature was 81,000 C.G.S. lines. The E.M.F. of the machine on open circuit at 1,000 R.P.M. is, therefore, equal to

$$3{,}000 \times 81{,}000 \times \frac{1{,}000}{60} \times 4 \times 10^{-8} = 162 \text{ volts.}$$

While this magneto operated excellently up to speeds of 1,000 R.P.M., it was not suitable for pleasure vehicles having engines capable of accelerating to double this speed. I was therefore led to design the type of inductor magneto described in Specification No. 5 in schedule herewith. In this machine both the armature and the permanent magnetic field were fixed, and the only rotating part was a light, easily balanced spider carrying laminated iron inductors. A considerable number of the type described in Figs. 5 and 6 were manufactured; but, while the magneto described in Specification No. 4 gives one complete cycle per revolution, that is, two maxima per revolution, and therefore suitable for one-, two-, or four-cylinder engines, that illustrated in Figs. 5 and 6 of Specification No. 5 gave two complete alternations, or four maxima per revolution. This was found to introduce a difficulty in the manufacturing of the trip cams. Further consideration of the problem led to the evolution of the magneto described in Specification No. 6 annexed hereto. This type is really a complete inversion of the Siemen's H armature magneto. Again the only moving part is a light rotor carrying inductors. The armature is mounted centrally, and takes a form similar to the well-known single-coil dynamo field magnet.

The two rotating pole pieces E and F do not change their polarity, but are permanently magnetised by the permanent magnetic field in such a way that the flux

always flows from the one to the other through the armature coil, first in one direction and then in the other. Although the leakage field in this machine is obviously considerable, a point which had to be clearly borne in view in designing it, the machine was a complete success, and gave excellent results in practice. Although this design is no longer manufactured as a standard by my Company, it is interesting to note that one of the largest American magneto firms has, within the last few years, standardised on a machine of this type.

In determining the angular position of the magneto relatively to the crankshaft, it is necessary to fix it so that a strong spark will be obtained for starting purposes at the speed at which the engine can be comfortably turned by the driver—say, 100 to 120 R.P.M. This spark may be permitted to take place as much as 15° before the top dead centre is reached without any risk of the direction of rotation of the engine being suddenly reversed by too early ignition, in view of the fact that the momentum of the flywheel at a speed sufficient to give an igniting spark is sufficient to carry it with certainty over the dead centre. As the speed of the engine increases it is necessary for maximum efficiency that the spark should take place at an earlier period of the compression stroke, in order that complete inflammation of the charge may have taken place when the dead centre is reached.

By means of a McInnes-Dobbie continuous-strip indicator I found that the lapse of time between the passing of the spark and complete inflammation of the charge varied under full load conditions from ·01 to ·006 second as nearly as might be judged.

In an article by Dr. Watson, appearing in "The Autocar" in November, 1907, he gives the period of inflammation at one-hundredth of a second for a rich charge, and in the case of a weak charge one sixty-eighth of a second.

Obviously this time is determined by a great many variable factors. Taking it for the moment at ·01 second, this is equivalent at 900 R.P.M. to 54° of rotation of the crankshaft. It is evident that the ideal magneto ought to have a reverse characteristic—that is to say, that the point at which the maximum spark occurs ought to occur earlier per revolution as the speed increases. A considerable amount of time and thought was given to the production of a magneto which would approximate to these requirements.

The best solution turned out to be an extremely simple one, and forms the subject-matter of the Patent No. 7 in schedule. Comparing Fig. 6 and Fig. 7 of this specification with Figs. 1 and 2 of Specification No. 4 in schedule, it will be seen that while in No. 4 the pole pieces have square edges—i.e., lying in an axial plane, having a comparatively small lap over the armature pole gaps—in Specification No. 7 the field magnet pole pieces have a substantially greater lap, and one edge or corner of each pole is bevelled away to about 30°; this we call the trailing pole tip, as will be seen from the direction of rotation indicated by the arrow.

Referring to the curves shown in Fig. 4, what we have termed the pole gap is equal to zero when the extreme trailing edge of the field magnet pole is in the same axial plane as the trailing edge of the armature pole—in other words, if one is looking down upon the magneto just when the pole piece is about to expose the armature winding to view. Curve A shows the length of spark obtained at a speed of 120 R.P.M. for various values of this pole gap. It is practically identical for magnetos built to either of these designs. Curve B shows the length of spark obtained at 900 R.P.M. for various values of the pole gap for a magneto constructed in accordance with Specification No. 4, and curve C the spark length curve at 900 R.P.M. for a magneto constructed in accordance with Specification No. 7.

With regard to the starting speed, it is apparent from the shape of the curve A that we have not very much choice as to the best setting to give an efficient starting spark. Assuming that for starting purposes we set the trip off at the point corresponding to a pole gap of 23°, from what has been said above we know that at a speed

of 900 R.P.M. the spark ought to take place 54° before the dead centre. To minimise the advance required for the magneto, let us assume that the starting spark has been fixed at 15° before the dead centre, the net advance now required will be 39°. We must now consider what length of spark the magneto will give when the pole gap is $23-39=-16°$.

We find that the vertical ordinate at this point cuts the curve B at 10 mms., whereas the starting spark is 14 mms. in length. Not only is this the case, but the curve B is rapidly falling, and a difference of 5° earlier in the point of ignition which might easily occur would bring us down to 4·5 mms. length, which would certainly not be satisfactory. On the other hand, the curve C at $-16°$ pole angle gives us 23·6 mms. spark, and we could go another 10° earlier and still obtain an ample spark. The maxima of B and C do not differ very greatly, both occurring about 10° pole angle, but this point does not greatly concern us; the other point does.

The generator, therefore, has a characteristic approximating closely to the ideal conditions, or has what we might call a reverse characteristic. It would appear that the magnetic lines at low speeds resist cutting till the last moment, and crowd into

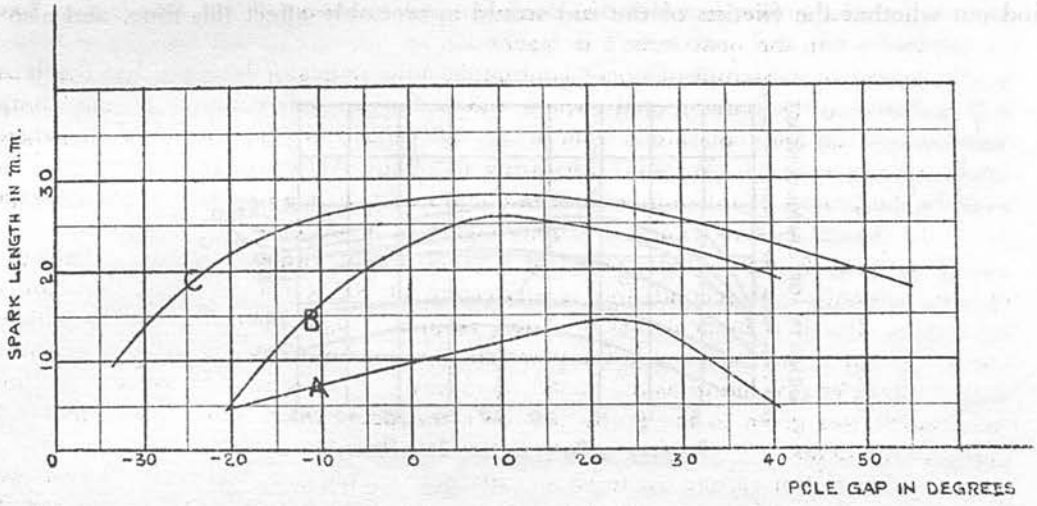


Fig. 4.

Diagonal Pole Gap Spark Length.

the triangular corner of the trailing pole piece, thus retarding the maximum spark effect until a clear gap has been formed, whereas, as the speed rises, a sufficient number of these lines are apparently cut as soon as the spiral trailing edge of the pole piece begins to leave the armature pole piece, with the result that there is a sufficient change of induction through the armature winding to give a satisfactory spark. The apparent reluctance of the lines to crowd themselves into the trailing pole tip at higher speeds is probably due to the fact that the field magnet pole pieces are solid, and a rapid redistribution of the lines in the face would set up considerable Foucault currents, and a balance between these effects takes place, depending upon the speed of the magneto.

Fig. 4a shows a series of curves taken from a later model magneto embodying the bevelled pole piece principles described in Specification No. 7 in schedule. A dotted line has been drawn through the maxima of the various curves, and this shows very clearly what we have termed the reverse characteristic, or, in other words, how the point of maximum spark length of this magneto occurs earlier in the revolution as the speed rises.

This feature of the bevelled pole pieces has now been adopted by many of the principal magneto manufacturers, and, as the curves prove, it attains a much-desired improvement in magneto design.

The trip gear used on Albion low-tension ignition system is illustrated in Fig. 14. In order to make the lag between the moment of release of the trip rod by the ignition cam and the passing of the spark as minute as possible, the trip rod was extremely light in design throughout. Its total weight was 4 ounces, and the impelling spring exerted a force of 8 lbs. The clearance at the ignition hammer was adjusted to about ·03 in. The time elapsing, therefore, between the trip off the cam and the commencement of rupture of the circuit is

$$t = \sqrt{\frac{2\,S\,w}{f\,g}}$$

$$= \sqrt{\frac{2 \times \cdot 03 \times \cdot 25}{12 \times 8 \times 32 \cdot 2}} = \cdot 0022 \text{ sec.}$$

This period of time has also been measured experimentally, partly in order to find out whether the friction of the rod would appreciably affect this time, and also

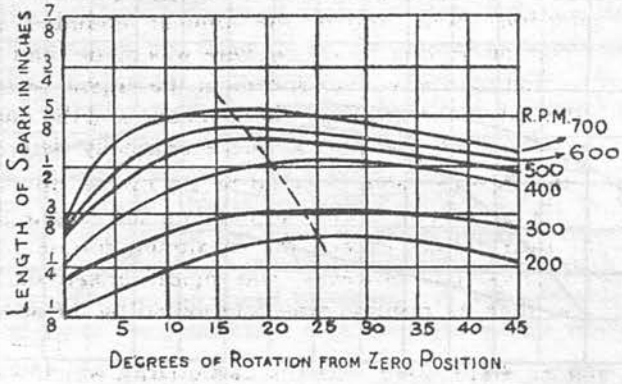


Fig. 4a.

to find out what amount of opening of the platinum contacts in the combustion chamber was necessary to cause ignition of the charge. As experimentally determined, the time was ·0025 seconds. It is interesting to note that, after the engine was thoroughly heated up, ·001 in. separation of the contacts suffices for ignition—that, in fact, ignition took place ·0025 seconds after trip off. At 900 R.P.M. this is equivalent of 13·5° rotation on the crank shaft, therefore the total lag between the time of trip off and complete inflammation of the charge at 900 R.P.M. is equivalent to 67·5°, and as the total lag may be taken as constant, the angle will be directly proportionate to the speed. Having an approximately straight line characteristic governor, it was, therefore, a straightforward matter to couple it up so as to automatically give the necessary advance for any given speed, which was accordingly

done with successful results. The mechanism is clearly shown in Fig. 14. Another form of magneto is described in Specification No. 8 in schedule, specially designed for three- or six-cylinder engines. An experimental machine was made, and operated satisfactorily, but no practical applications of this machine have been made.

The original Albion carburettors consisted of the well-known device in which the air, being drawn into the engine by the downward stroke of the piston, passes through a vena contracta in which is arranged a jet, the fuel being maintained near the level of the top of this jet and the reservoir supplying the jet, open to atmosphere. The reduction of pressure over the jet, owing to the restriction of the air inlet and to the velocity of the current over the jet, causes a flow of fuel from the jet, the fuel being broken up into a fine spray and thoroughly mixed with air. While for any given velocity of air the jet can be so proportioned that a correct mixture of air and fuel results; for any greater quantity of air the amount of fuel will be in excess of that requisite to produce the best mixture, while for lesser quantities of air the mixture will be too poor. Generally speaking, therefore, larger quantities of air are required at higher engine speeds. Having attached to our engine a governor which could control and set the position of any device within its range of speed, it was decided to arrange the carburettor as illustrated in Patent No. 9 in the schedule.

The vena contracta and jet were proportioned to give the correct mixture at low engine speed developing full torque, and in the annular chamber surrounding the vena contracta a port communicating to atmosphere was made, and the approximate best area of this port for full load at various speeds of the engine were experimentally determined; and with the aid of the governor characteristic and the data obtained from these experiments, the shape of the port K was empirically determined.

In the carburettor the throttle valve D could be set by the driver to close at any desired point on the range of governor, and so maintain the engine speed at or near this limit so long as the load did not exceed the maximum torque of the engine for that speed. The speed air valve L, however, was rigidly linked once for all to the governor mechanism, so that its position was determined by the speed of the engine alone.

A number of engines were fitted with this carburettor, which was a very distinct improvement upon the earlier one, but, in practice, one outstanding deficiency soon came to light. While the engine worked excellently at all speeds from half to full torque, at high speeds at light loads trouble was experienced with back-firing into the carburettor, indicating too weak a mixture. Obviously at these high speeds and light loads the velocity of air over the jet was not only low, but too great a proportion of the air entered by the port K, causing further attenuation of the charge. Consideration of the problem led to the evolution of the design illustrated in Specification No. 10 in schedule.

A new set of experiments were undertaken to determine the permissible area of K, from minimum to full speed, with the engine running light at each speed. Another set of experiments were taken to determine the amount of opening of the piston valve V, necessary at various speeds to give full load. From the first of these series of experiments a new port K was deduced, which was termed the " speed air port," and an additional port A B, termed the " load air port," was introduced in the piston throttle valve D, its total area, in conjunction with the port K, being equivalent to the total area of the port K in the previous Specification No. 9.

The axial length of the port B was based upon the results got in the second series of experiments, determining the necessary travel of the piston valve D to give substantially full load. A point, something like 6 per cent. under full load, was chosen as the curve of opening necessary for full torque, and as one would expect, gradually reached an asymptote.

A large number of these carburettors were manufactured during the five years following the date of the patent and operated very successfully.

Subsequent investigations, however, made it clear that this carburettor, owing largely, no doubt, to internal air friction arising from the tortuous passages, did not give as high volumetric efficiency in the engine as was desirable. Owing to the friction of the piston valve, the accuracy of governing was not all that could be desired, and in future designs this point was kept clearly in view. With anything but the lightest grades of fuels also it was necessary to effect a preliminary heating of the air, and this caused a diminution of the charge. A few preliminary experiments showed that it was only necessary to heat the air actually passing over the jet, and that when once a saturated vapour had been formed, one could introduce a large

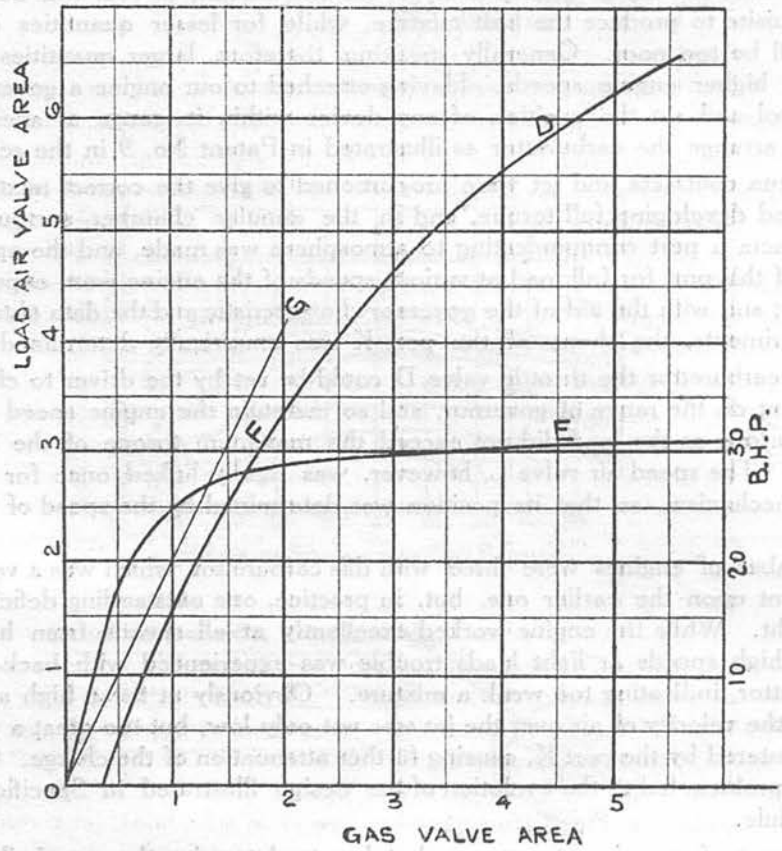


Fig. 5.

Gas and Load Air Curve.

quantity of cold air to the mixture without apparently any detrimental effect. It was therefore decided to mix the fuel in the first instance with only one-third or so of the air necessary for proper combustion, and to carry this along a hot-jacketed conduit, which was found to be as effective as pre-heating of the air, and more convenient, and then close to the inlet valves dilute with the necessary amount of cold air.

The general style of carburettor evolved is described and illustrated in Specification No. 11 in schedule.

The rich mixture from the spray device passes through the gas valve B, while the additional air necessary to make it a proper combustible mixture passes through

the valve C1, mixing in the chamber B1 and passes to the engine by the port B2. An exhaustive series of experiments were carried out with a carburettor arranged on those lines, but with the valves B and C1 separately controlled by axial screws, each being fitted with a disc divided into degrees, so that the opening of each valve could be directly determined.

The engineer must have ever in view the practical side of the question and the limitations of the workshop, and his aim must be to secure a reasonable approach to scientific accuracy, while designing something which can be produced in a straightforward way in the factory, and can be readily checked by gauges. From the results thus obtained were plotted curves showing at all speeds and loads the relative areas necessary past these valves to ensure the correct mixture. From an examination of these it was seen that, provided that the opening of the valve C1 was not greater than that necessary to ensure a fair velocity past it, or, in other words, an appreciable amount of wire drawing at it, then for any given opening of B a fixed satisfactory value for C1 could be found.

The curve D in Fig. 5 indicates the correct ratio between the areas of the load air valve and the gas valve for any conditions between light load minimum engine speed and full load maximum speed. The curve E shows the horse-power developed at 900 R.P.M. for various openings of the gas valve, the load air, of course, being kept at any particular reading in accordance with the values determined by the curve D. As one would expect, this curve rapidly approaches an asymptote. To render the ratios between the gas and air valves effective, we require to have, as indicated above, a certain amount of wire-drawing past these valves. It is reasonable, therefore, to choose the point F on the curve D as the limiting top value for the openings of the " load air " and " gas " valves with which we are concerned at the moment. This amount of opening of the gas valve will give us 28·2 B.H.P., at 900 R.P.M., as we see from curve E, and which is only 8% less than the maximum obtainable from this engine at that speed. As this engine is not intended to develop more than 32 H.P, or to run at a higher speed than 1,000 R.P.M., the above allowance is ample.

An examination of the curve D from the point E to the abscissa shows that this portion approximates to a straight line, and might be expressed without serious error by the equation

$$x = a\,y + C$$

As I have indicated above, the engineer must always aim at some compromise which shall be sufficiently accurate for practical purposes, and make the construction of the apparatus a practical and commercial possibility.

The line O G indicates the ratio that was chosen, being parallel to a tangent at the point on D, round about which the engine will be operating for the major portion of its life.

Reverting again to Fig. 1 (Specification No. 11 in schedule), let us assume for the moment that the speed air valve H is entirely removed, and that the load air valve C1 opens direct to atmosphere. If now we assume the load air valve opened considerably beyond the maximum area shown in the curve D in Fig. 5 the result would be that even at maximum engine speed there would be practically no reduction of pressure below atmosphere in the chamber B1, wtth the result that very little, if any, fuel would be sucked up from the jet, and practically no gas would come through the valve B. With our variable-speed governor control, this is precisely what would happen if the driver had the lever D5 set for maximum speed and the engine were running at or about its minimum speed, which might occur if the vehicle were climbing a hill requiring greater torque than the engine maximum, and on which the speed were continuously falling, and the valves B and C1 being correspondingly opened up further and further by the governor. Experiments have shown that in actual practice, under working conditions, the absolute pressure in the

chamber B1 varies from ·37 to ·95 atmospheres. Bearing these points in view, it was resolved to make a series of tests determining the amount of air necessary for full torque at any speed from minimum to maximum, the valves B and C1 being, for the purposes of these experiments, sufficiently held off their respective seats as to render their existence practically negligible. The values so obtained are shown in the curve L, Fig. 1, which gives the full torque area of what we have termed the " speed air valve " for any given speed of the engine. It will be noticed that the curve commences at a speed of about 240 R.P.M., which is the lowest speed at which it is practical, or necessary, to run this engine at full load with standard fly-wheel, and the standard fly-wheel is only proportioned accordingly, as saving of weight is of the essence of design in motor car construction. At this speed the area required past the speed air valve is ·26 square inches, and as the speed air valve is never less than this, we may conveniently provide it in the form of a constant opening. This is done by providing a series of holes in the register valve J, clearly seen in Figs. 1 and 2. As explained in the Patent Specification No. 11, this is made as a register valve purely for the purpose of starting, when, owing to partial condensation of the vapour in the cold inlet passages, etc., it is necessary to draw into the engine a super-carburetted mixture. For this purpose, the knob J2 gives the driver a convenient method of closing this valve, but a spring J1, however, ensures that it cannot be left—otherwise than full open—and so provide the constant portion of speed air area above mentioned.

The remaining portion of the curve L approached a parabola, and, therefore did not lend itself to the same simple treatment as the portion of the curve D with which we had to deal. The values of L at the various speeds were taken in conjunction with the mean of the governor characteristic H K, and a valve empirically determined and directly connected to the governor, which, at any given speed, gave, in conjunction with the already mentioned constant speed air area, the total speed air necessary for that particular speed. This valve H and its method of operation by the governor is clearly seen in Fig. 1 of Specification 11.

Reverting again to the curve D, the constant C might have been provided by arranging that the valve B had a small initial lift off its seat when the valve C1 was seated. Both of these valves are conical in design, and for the comparatively small lift employed within the limits of the point F, the areas past each valve may be taken as $\pi\ d\ l\ sin\frac{\theta}{2}$ where d is the diameter, l the vertical lift, and θ the angle of the apex of the cone. Practical considerations, however, make it desirable that these two valves should seat simultaneously, and, as a matter of fact, should be ground to their seats to secure accuracy. The constant C in our equation

$$x = a\,y + C$$

therefore, was provided by means of a by-pass L through the seat of the valve B, and having a slight amount of adjustment provided by the screw L1, which could only restrict it, but not close it. To provide for various grades of fuel, and variations in atmospheric conditions, a small by-pass A was arranged on the vena contracta which could vary the richness of the gas to a slight degree, and while giving a skilled driver the opportunity of getting the best results, had so narrow an influence on the mixture that its total neglect would not prevent reasonably good results being obtained. It will be further seen that this carburettor more closely approaches the ideal already laid down, in that the valves to be operated by the governor are practically frictionless. The pressure reactions from the gas and load air valves nearly balance, as in actual practice the difference of diameter is much less than Fig. 1 indicates. Sharp bends and eddies in the air passages were avoided, while the valves themselves had a streamline design. Subsequent investigations led

to the substitution of what has been termed the "Pilot Valve" (see Figs. 1 and 3, Specification No. 12 in schedule). This valve superseded the adjustable by-pass L, and provided the constant C required in our equation. This simple by-pass L, had the following disadvantages:—

After engines had been thoroughly run in, it provided so much mixture that the speed of the engine running light, with the vehicle at rest, was excessive, and to check down the area meant upsetting the proper ratio of gas and load air by reducing the constant C too far. Also when a vehicle was running down hill with the engine actually being driven by the gradient, gas was still being drawn into the engine with corresponding waste of fuel.

Referring now to Fig. 1 (Specification No. 12 in schedule), the first proposal was to place a tiny poppet valve in the by-pass aperture and operate it by the governor control, slightly in advance of the main gas and load air valve, it being so proportioned that when the governor was just about to operate the gas and load air valves, the air past the by-pass valve M was equal to C. At low speeds, light load, the governor kept the speed down to the lowest limit by means of the pilot valve N. On down gradients, as soon as the engine was being driven by the car beyond its governed limit, the valve N was closed by the governor, and all waste of gas ceased. The next improvement was to incorporate the valve N concentrically with the gas and load valve, as shown in Fig. 3 (Specification No. 12), still giving it the necessary lead to provide the constant C.

In Specification No. 13 in schedule, an alternative design for a small model is described and illustrated, but the modus operandi is similar to Nos. 11 and 12.

In actual service the combined carburettor and governor have given most excellent results, and have been particularly free from accidental derangements or troubles of any kind.

I have carried out a very considerable number of experiments in connection with the use of the heavier hydro-carbons as the fuel for internal-combustion engines for the propulsion of motor road vehicles (Specification No. 14 in schedule) shows diagramatically a promising type of vaporiser for this purpose.

Described shortly, the proportions of air and liquid fuel are measured by the respective areas of restricted passages with suitable compensating devices to maintain the correct proportion of air and fuel, as already described in the case of carburettors for lighter hydrocarbons, but in this instance no attempt is made in the measuring device to atomise or vaporise the liquid fuel in any way; in fact, means are taken to prevent this happening. The necessary fuel and air are taken into an intermediate chamber, connected to which is a simple air pump driven from the engine, drawing the already measured air from this chamber and forcing it to a spray device, to which the already measured fuel is fed by gravity; this transforms the mixture into a finely divided mist, and it is immediately passed into a heating chamber, jacketed by the exhaust gases. From this chamber issues a sufficiently stable gas to satisfactorily operate the engine. Only preliminary trials with this device have been possible, as, owing to the outbreak of the world war, a great deal of such research and pioneer work has had to be postponed *sine die*.

Where an internal-combustion engine has to operate at a high speed for long periods without any attention, the question of lubrication is naturally one of importance. In motor car work generally, the earliest engines were lubricated by having a certain quantity of oil in the crank-case which was splashed up by the connecting rod ends, and led by a more or less imperfect system of gutters, to the other working parts of the engine. In improved designs, circulation of the oil was effected by some species of pump, and at the present day the circulated oil is in many cases fed to the crank-shaft bearings under pressure. In many instances the lubrication system is still decidedly primitive. After conducting

lengthened road tests with similar engines running under similar conditions, one lubricated with pure fresh oil fed regularly to the bearings, while the other was lubricated by a quantity of oil continuously circulated throughout the engine, an examination of the bearings showed very clearly that the method of lubricating by circulation of oil was far from ideal. The oil in the crank chamber became foul, partly, no doubt, through a certain amount of finely divided dust and grit being washed down the cylinder walls, and the quality of the oil as a lubricant being thereby rapidly deteriorated, with corresponding results upon the bearing surfaces. Especially is this the case in engines using as fuel heavier hydrocarbons, as a small proportion of this heavy fuel almost invariably finds its way in liquid form past the pistons, and combines with the lubricating oil, reducing its lubricating properties. It was therefore necessary to devise a lubricator which would supply a definite quantity of pure fresh oil to each of the bearings at stated intervals. The first device evolved is shown in Patent No. 15 in the schedule. A definite quantity of oil was measured and delivered to each bearing by alternately filling up from a reservoir a cylindrical hole in a rotating disc or equivalent device, and bringing this hole with this charge

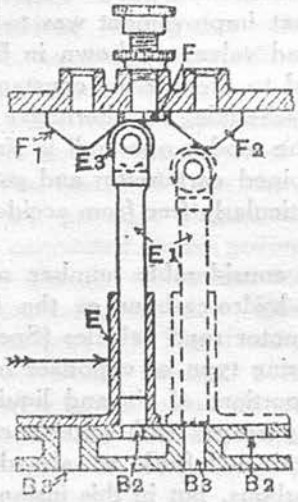


Fig. 6.

Diagram Murray-Albion Lubricator.

of oil in line with the supply pipe to that particular bearing, down which the measured quantity of oil was duly delivered by gravity. The apparatus was simple, and would have been quite satisfactory where no risk of back pressure existed, but in the case of leaky pistons this is a trouble which arises in cylinder lubrication. One other drawback of this lubricator was that the same quantity of oil had to be supplied to each of the bearings, as the apparatus permitted of no individual adjustment. To overcome these objections the lubricator described in Specification No. 16 in the schedule was then devised. As will be seen, it is a development of the idea described in Specification No. 15. The whole apparatus is mounted in a box forming the reservoir for the oil to be fed to the engine. On the bottom of the box is fixed a circular disc at a certain radius of which is a series of equally spaced vertical holes. The upper portion of the disc is machined truly flat to receive a rotating disc. Each alternate hole in the fixed disc communicates on the underside freely with the oil in the box, while the remaining holes pass through the disc, and are connected by lubricating pipes to the engine bearings, etc. The rotating disc forms an oil-tight

joint with the fixed disc, and is kept so by a suitable spring. This disc carries at the same radius as the holes in the fixed disc a simple plunger pump whose axis is normal to the disc, carrying at its upper end a roller which is pressed against a cam path arranged on the lid of the reservoir. The action on the device is clearly shown in the accompanying Fig. 6. In the full line position the pump plunger has just completed the charging stroke by passing from left to right, and at the same time the spring has forced the roller up the sloping surface of the cam F_1, and a charge of oil has been drawn in through the port B2. As the disc with its pump moves to the dotted position, the contents discharge down the port B3. The pump then passes on, and as the plunger rises up the right-hand side of F2 a fresh charge is drawn in through the next port B2. By means of adjustable stops F the pump may be given less than full stroke, and a correspondingly reduced quantity of oil taken in and discharged to the next succeeding delivery port. To avoid any possibility of air locks the cam path is so arranged that the bottom of the pump plunger E1 is just clear of the fixed disc and no more as the roller passes over what may be termed the high points of the cam path. There is of course sufficient lap between the ports to ensure that the pump has passed a little beyond the suction port before it begins to open to the succeeding delivery port, and similarly between the delivery port and the succeeding suction port. The cam path is so arranged that no motion of the plunger takes place during these dead parts of the travel. The device is obviously elementarily simple, and, as one would expect, there being no valves, and no motion of the plunger taking place until the ports are in a suitable position, the volumetric efficiency of the pump is 100 per cent. The device will pump easily against a pressure of 200 lbs. per square inch, which is probably 40 times as great as is ever required in motor car work. This type of lubricator has been fitted exclusively to all Albion engines for the past eleven years, and not a single failure has been experienced.

Figs. 19 and 20 show the actual design and method of operation of this lubricator, as fitted upon the 32 H.P. three-ton commercial vehicle model. It is constructed as an integral portion of the engine crank-case, and is driven at a definite speed ratio from the engine, so that each thousand revolutions a definite quantity of oil (adjustable by the driver within certain limits) is pumped to each of the cylinders, main bearings, and connecting rods of the engine.

In 1901 it occurred to me that the wear and tear of the transmission mechanism of a motor vehicle might be considerably reduced and smoother working obtained by introducing a spring torque member at some point in the driving mechanism. An experimental device showed that the maximum torque in transmission gear occasionally rose through various causes to twice the maximum mean torque developed by the engine. Various forms of spring drive were fitted with considerable success. One of these is illustrated in Patent No. 17 in the schedule. In this device the torque is transmitted through a large spiral spring, whose axis coincides with the axis of the driving shaft. In the event of this spring failing the drive is taken up by a jaw clutch mounted within it, but in normal conditions the jaws of the clutch never touch. The improvements which have been effected in the main friction clutch through which the power is transmitted from the engine to the road wheels, have made it possible to do away with this device, and though ideal considerations would advocate its retention, commercial limits often compel the engineer to compromise on a matter of this kind.

Specifications Nos. 18, 19, 20, 21, 22, 23, deal with successive improvements connected with the main friction clutch, and indicate the evolution of the present-day type, which leaves little to be desired. The two earlier of these specifications deal with clutches in which the working surfaces were both of metal, and the whole clutch was immersed in lubricant, but owing to the fact that the coefficient of static

friction was so much greater than the coefficient of friction when in motion, this type of clutch never really gave satisfactory results.

That illustrated in No. 20 is the Albion standard for the three-ton War Department vehicles, and the excellent service it has given and is giving under the most strenuous conditions is proof of its satisfactory nature. The friction faces in this case are woven asbestos fabric and polished steel plate. The coefficient of static friction with these materials is very little higher than the coefficient of friction, even up to a considerable relative velocity between the two friction faces, consequently the clutch takes up its work smoothly, no matter how careless the driver, and if the springs are properly proportioned will slip slightly under excessive torque, and save the engine and gearing.

Specifications Nos. 21, 22, and 23 deal with refinements of this type of clutch, and describe devices for ensuring that the driving plate is freed from both of the driving surfaces, and not, as sometimes happens, from one only, leaving it to drag against the other.

Specifications Nos. 24, 25, and 26 in the schedule indicate that some thought has been given to the construction of piston valve engines, the idea being to eliminate cams and the drawbacks connected with poppet valves and their actuating gear. Engines were made in accordance with Specifications 24 and 26 in the schedule, and while these operated satisfactorily enough, investigation did not lead one to expect that they would prove superior in actual everyday work to the better-known poppet valve type, or that they would be cheaper to manufacture or maintain. In the last few years improvements in machines for producing accurate cams, and also the use of more suitable steel for poppet valves, has largely eliminated the weak points of the poppet valve system.

As I have great faith in the possibilities of what is known as the two-stroke type of internal-combustion engine (known generically as the Day type engine), for the propulsion of motor vehicles, naturally some attention has been devoted to this type. In its simplest form it has but three moving parts—the crankshaft, the connecting rod, and the piston, and if without adding appreciable complications it can be made reasonably efficient, it ought to find a very wide application in the construction of motor vehicles for light loads. So far the researches have been of a preliminary and exploratory nature.

Specification No. 27 in schedule describes a double unit two-stroke motor embodying U tube construction of cylinders for the purpose of preventing loss of live charge through the exhaust port. In it crank-case compression was employed, and to secure fuel efficiency, which is difficult to obtain with this class of engine, especially at light loads, one unit was cut out by the governor when the load fell below a certain limit, thus ensuring a large charge and consequently higher thermal efficiency in the other cylinder pair. The kinetic balance of rotating and reciprocating parts in this design was poor, unless the more complicated design shown in Fig. 3 were adopted.

No. 28 describes a type of engine having a balance similar to the standard four-cylinder motor car engine operating on the Beau de Rochas cycle, but it only gave one impulse per revolution. The two outer cylinders operated respectively as air and gas pumps, so the drawback of crank-case compression was avoided. The air cylinder and its ports were given a " lead " over the gas cylinder, so as to interpose a layer of uncarburetted air between the exhaust gases and the fresh combustible charge. The idea was both to prevent pre-ignition of the charge by contact with the hot exhaust gases, and that such portion of fresh charge as might escape through the exhaust port would presumably be pure air, and therefore negligible. An engine of this type was constructed and tested, and its absolute simplicity was most attractive to the engineer. At full load it operated fairly well, but at light loads

the fuel efficiency was very poor. As compared with the tests carried out on a simple Day type engine, no advantage could be traced either to the U tube construction of working cylinders or to the separate construction of air and gas pumps, or to the precession given to the former.

Specification No. 29 in schedule describes an engine on similar lines, giving two impulses per revolution, and calls for no special description.

From the information gained in these preliminary experiments, the engine described in Specification No. 30 in schedule was next devised. Having six cylinders with cranks spaced at 120°, and pistons and connecting rods all of equal weight, it would of course give the wonderfully perfect balance of the well-known six-cylinder type of motor car engine, and as it had three working cylinders, each giving one impulse per revolution, the torque would be similar to that of the six-cylinder Otto cycle engine at full load. The engine consists really of three unit pairs, one cylinder of each unit forming the pump and the other the working cylinder. Inlet valves to the pump may be dispensed with by forming a port uncovered by the piston, but an automatic inlet valve is simple and more efficient. A similar valve is introduced between the pump and its working cylinder. In view of the phase difference between the pump and the working cylinder it is necessary to curtail the volume of the receiver chamber for one of the unit pairs. It was intended to overcome the difficulty of obtaining efficiency under light loads by cutting out either one or two unit pairs entirely and throwing the whole work on to the remaining cylinders or cylinders. The whole scheme promised extremely well, especially for light vehicles, but, unfortunately, owing to the war, it has been impossible to build an engine of this type, or to prosecute any further research in connection with two-stroke engines.

Noise in the gear wheels driving the cam shafts, which gears are generally mounted at the end of the crankshaft, remote from the flywheel, led me to investigate the torsional rigidity of a standard four-cylinder crankshaft. It was found that the maximum torque due to explosion pressure in the cylinder most remote from the flywheel set up 1·1° torsion in the crankshaft. As the clearance between the gear-wheel teeth at the pitch line does not exceed the equivalent of ·09°, it was obvious that this crankshaft distortion would set up considerable speed variations in the timing gear.

Specification No. 31 in schedule shows the device which was evolved to largely eliminate this objectionable point. The pinion driving the timing gear, instead of being rigidly keyed to the crankshaft, was driven from it by a torsion spring which, while ample to transmit the necessary power without appreciable distortion, was sufficiently flexible to absorb these distortions of the crankshaft, and the device made the running of the timing gear very much smoother and quieter.

Specification No. 32 in schedule describes a compact method of arranging the water-cooling and circulating device in motor vehicles, and forms a standard device on all Albion vehicles. It will be remarked that the usual vortex chamber generally incorporated in a centrifugal pump design is in this instance entirely absent. As a matter of fact two similar models were constructed, one having an orthodox vortex chamber, and the other entirely without, and carefully tested. The results showed that the power required to drive each model at a given speed was similar, and that the discharge efficiency of the model without the vortex chamber was only 6 per cent. less than that designed in the orthodox way. As this pump is purely used as a circulator it has no static head to work against, but merely a kinetic head due to friction in the water passages, in view of these results it was at once decided to simplify the mechanism by deleting the vortex chamber, as the difference of efficiency for our purposes was absolutely negligible, and a considerably simplified construction was obtained.

For commercial vehicles one desideratum is a good reliable and efficient head-

lamp. For this purpose an electric lamp with parabolic mirror is easily the most satisfactory. The problem, however, is to devise a simple method of generating the necessary current, as accumulators with their many drawbacks are complications one desires to avoid in commercial vehicle work. Bearing in mind that the head-lamp is only required while the engine is running, as oil side- and tail-lamps are quite sufficient for halts, we decided to use a small electric generator sufficient only to supply one or two head-lamps driven direct from the engine. A little preliminary investigation showed that this generator must be so constructed as to have a constant E.M.F., even while the driving mechanism varied in speed as much as from one to two. No attempt was made to solve the problem by electrical devices, as it was felt that a mechanical device would be more easily understood by the driver, and therefore preferable.

Specification No. 33 in schedule shows the device first designed. An electric generator, which might be either of the permanent magnet type or a simple shunt or series wound dynamo, was designed to give the desired output at a given speed. Upon the shaft of this generator was mounted a belt pulley or friction pulley geared to the engine in such a ratio that at half engine speed, assuming the pulley to be keyed to the generator shaft, the proper E.M.F. and current for the lamps would just be generated. This pulley was mounted on ball bearings on the shaft, and could only transmit torque to the generator shaft through a friction disc and face, the torque transmitted being directly proportional to the coefficient of friction between the faces multiplied by the pressure thereon, and a simple form of spring adjustment was provided. With the friction faces made of polished steel for the one member, and woven cotton fabric for the other, fairly satisfactory results were obtained, so long as the clutch was kept slipping at all, but if the speed of the pulley fell so far that slipping ceased the torque rose, corresponding to the greater value of the static friction between the surfaces than that of the friction coefficient when slipping was taking place, and there was a corresponding rise in the E.M.F. until the increased torque again set up slipping. To overcome this drawback a simple form of centrifugal governor was added, as shown in Figs. 1, 2, 3, and 4 of Specification No. 34 in schedule calculated to act at slightly above the normal speed of the generator. This effected the desired improvement, but a slight tendency to hunting was observed. This latter difficulty was entirely cured by the simple expedient of fitting what we have termed a "breather" spring L of very short amplitude, which had the effect of damping out these pulsations. It was found convenient to leave the generator running at all times when the engine was running, and when the head-lamps were not required it was switched off, so that the armature only ran idle, and there being no appreciable torque, the speed of the armature was above normal. In the case of magneto generators, where the E.M.F. on open circuit is directly proportional to the speed, to prevent damage to the lamps through switching on while the E.M.F. was excessive owing to this high speed, a simple switch device was evolved, as described in Patent Specification No. 35 in schedule. This, first of all, short-circuited the armature, and this brought down the speed below normal before switching the lamps in circuit. In the case of shunt wound generators, to cut off the exciting current when idle, the simple arrangement described in Specification No. 36 in schedule has been adopted. The field magnet shunt coil and the lamp are arranged permanently in parallel, and the connection to one of the brushes is broken by a simple switch. While this device, of course, would be most unsuitable on large generators, it operates perfectly in the case of such small machines as we are dealing with, the lamp forming a discharge path for the induced current from the field magnet coil when the circuit is broken.

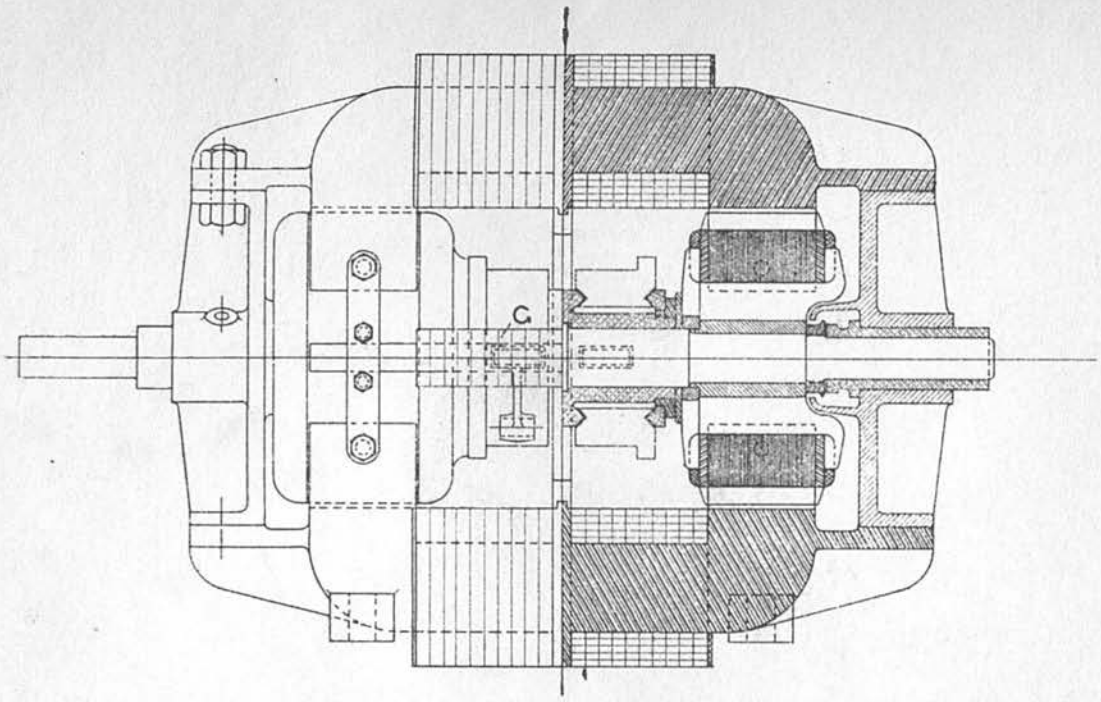
As indicating the importance of the work on which I have been engaged, I

may mention that the Albion Motor Car Company Limited, of which I am Chairman and Chief Engineer, is at present employing 1,800 hands in the construction of 32 H.P. 3-ton vehicles for H.M. War Office, designed throughout by me, and constructed under my Patents, and over two thousand of these vehicles are at present operating most successfully in the various war areas.

I hereby declare that I have personally undertaken these researches, and that I am the true inventor of the devices described in these specifications.

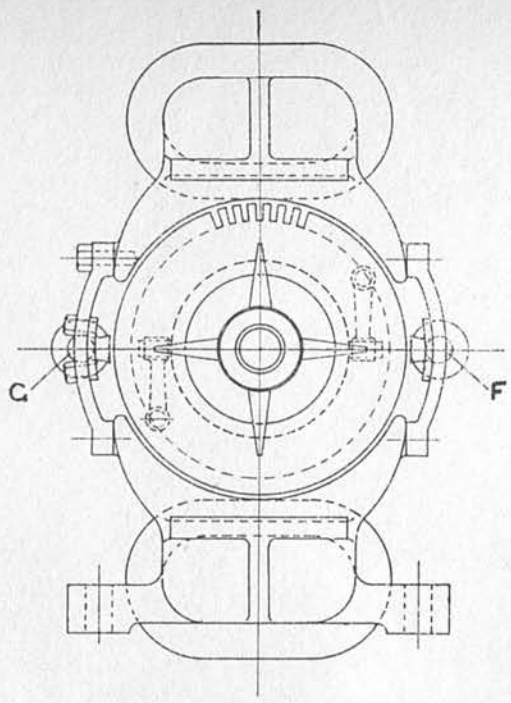
T Blackwood Murray

26th Dec 1916



SIDE ELEVATION. SECTIONAL ELEVATION

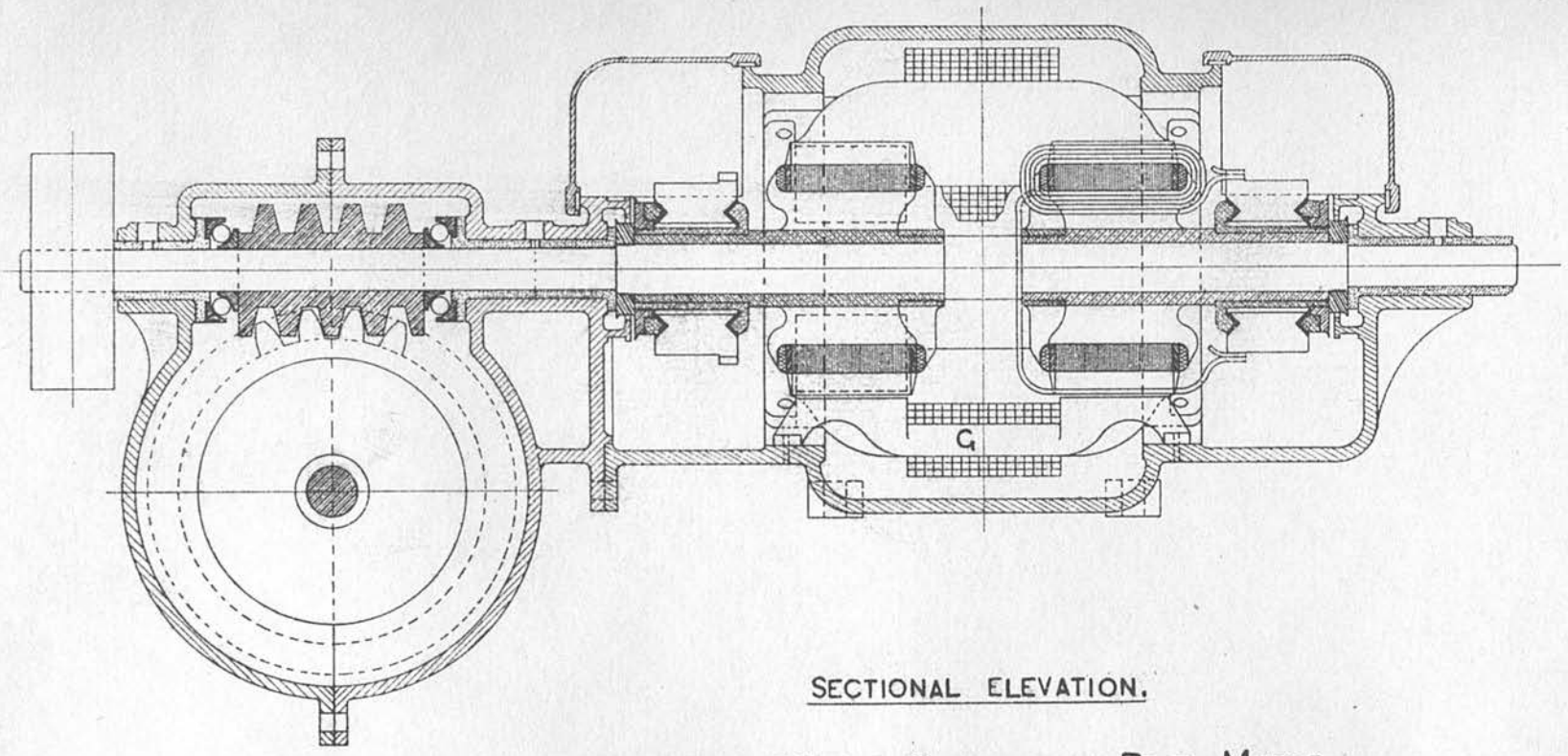
Fig. 7.



END VIEW

Fig. 8.

TWO POLE MURRAY COMMUTATING POLE MOTOR

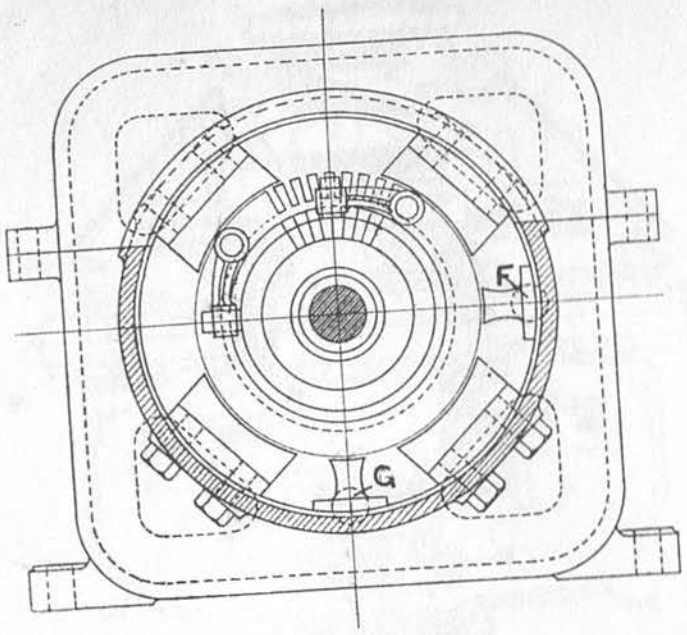


SECTIONAL ELEVATION.

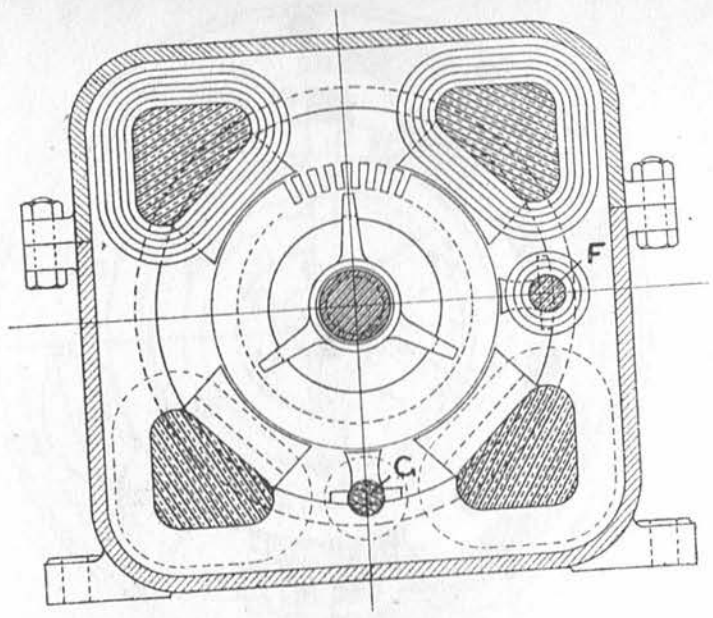
FOUR POLE MURRAY COMMUTATING POLE MOTOR.

WITH WORM GEAR TRANSMISSION

Fig. 9.



END VIEW

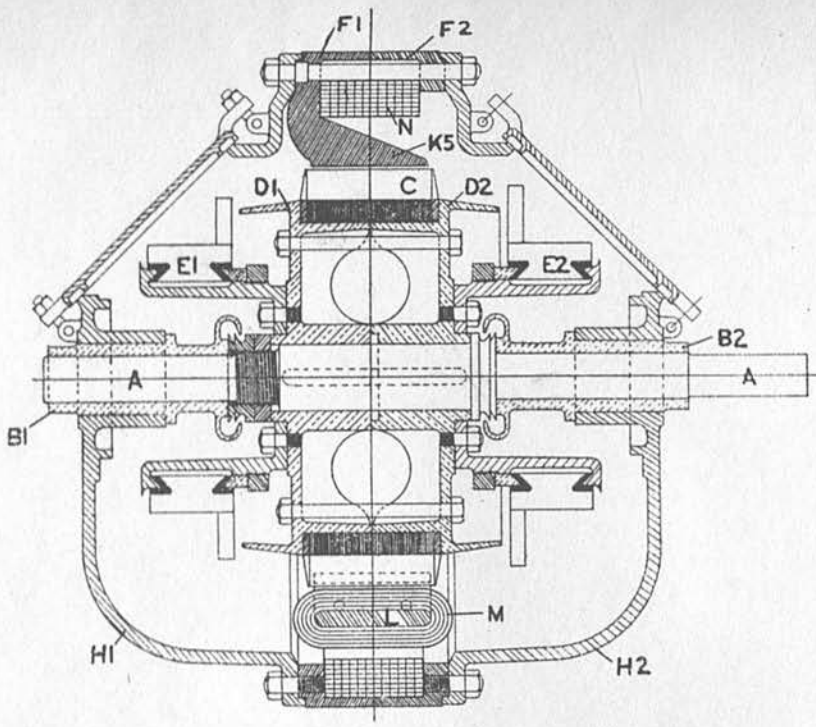


CROSS SECTION

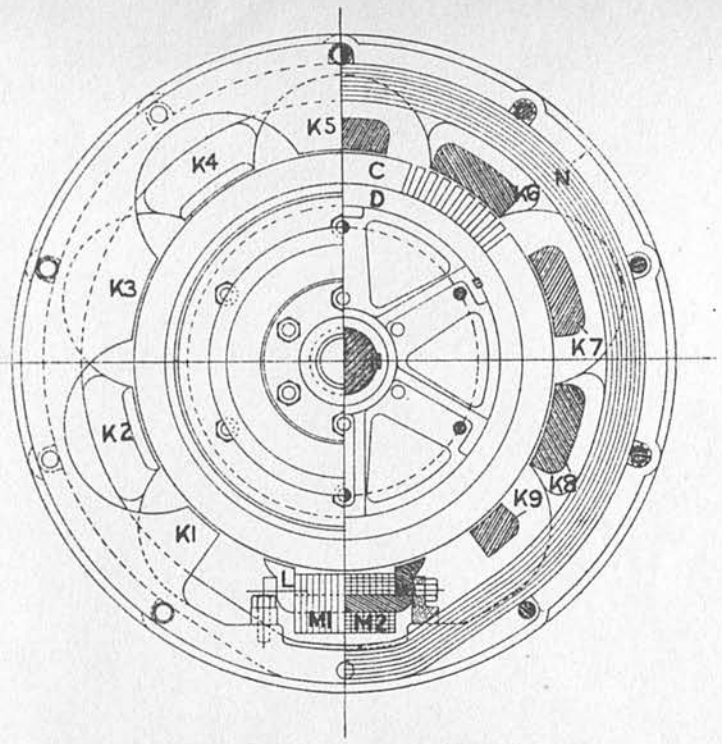
FOUR POLE MURRAY COMMUTATING POLE MOTOR

Fig. 10.

Fig. 11.



SECTIONAL ELEVATION.



END VIEW. CROSS SECTION.

F.M.s Exposed.

EIGHT POLE MURRAY COMMUTATING POLE MOTOR.

Fig. 12.

Fig. 13.

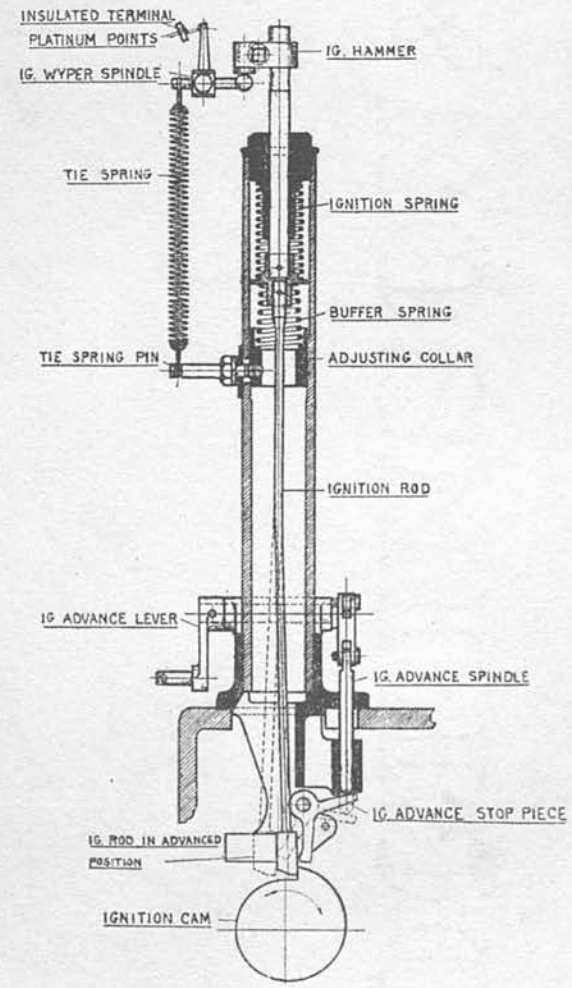


Fig. 14.

Arrangement of Murray Albion Low-Tension Magneto Ignition Trip Gear.

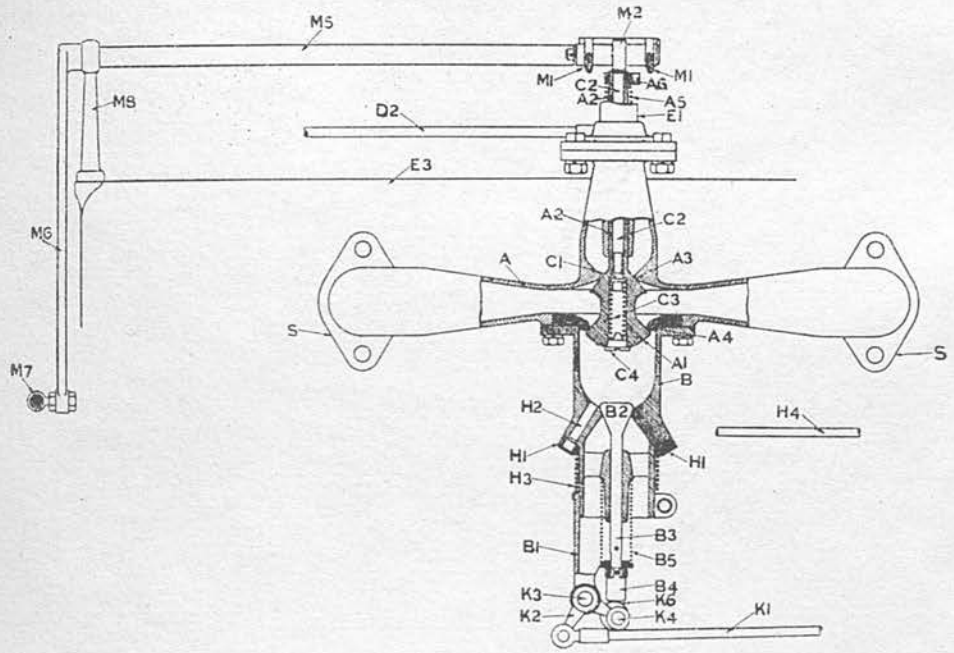


Fig. 15.

Longitudinal Arrangement, Murray Albion Carburettor, 3-ton War Department Model.

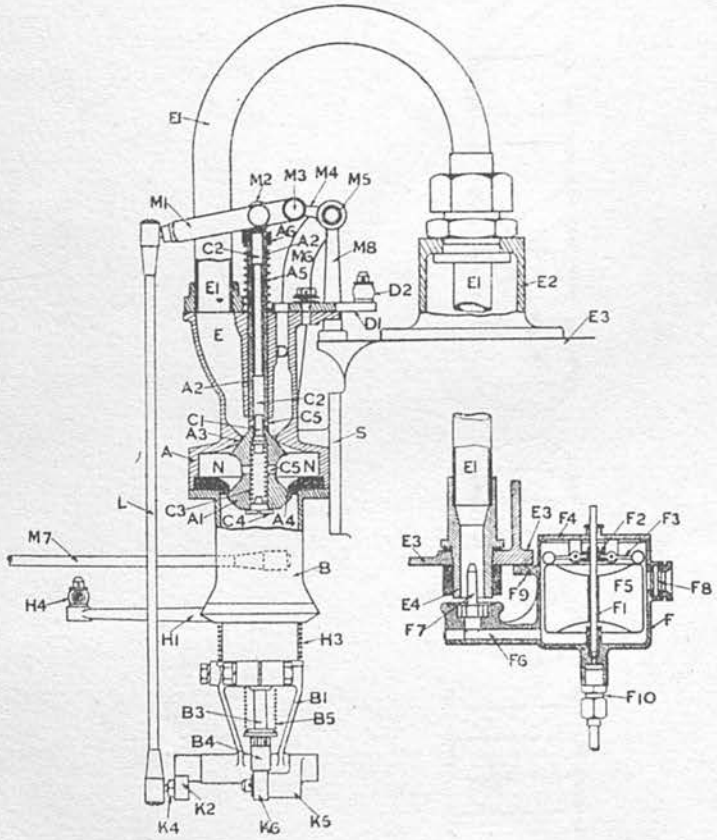


Fig. 16.

Sectional Arrangement, Murray Albion Carburettor, 3-ton War Department Model.

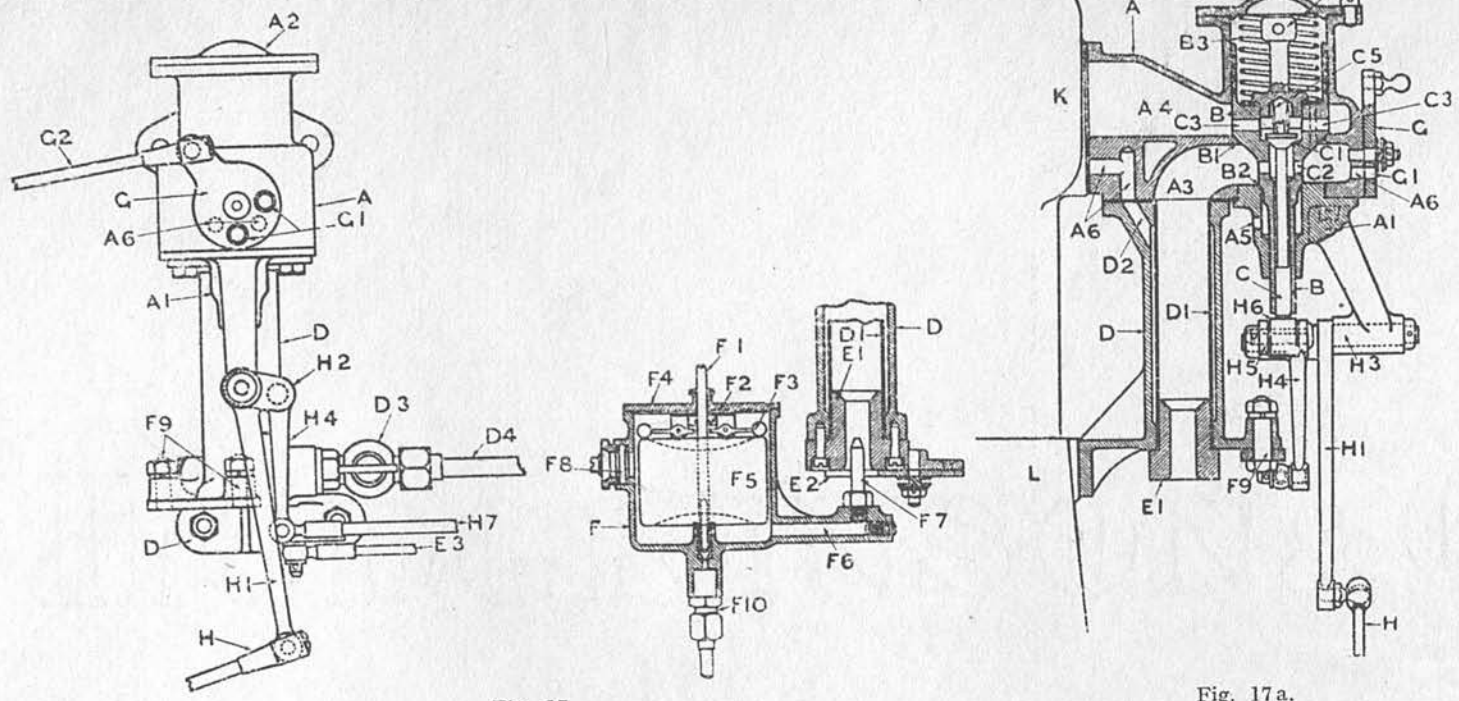


Fig. 17.

Longitudinal Arrangement and Section of Float Chamber, Murray Albion Carburettor, 15-cwt. Model.

Fig. 17a.

Sectional Arrangement, Murray Albion Carburettor, 15-cwt Model.

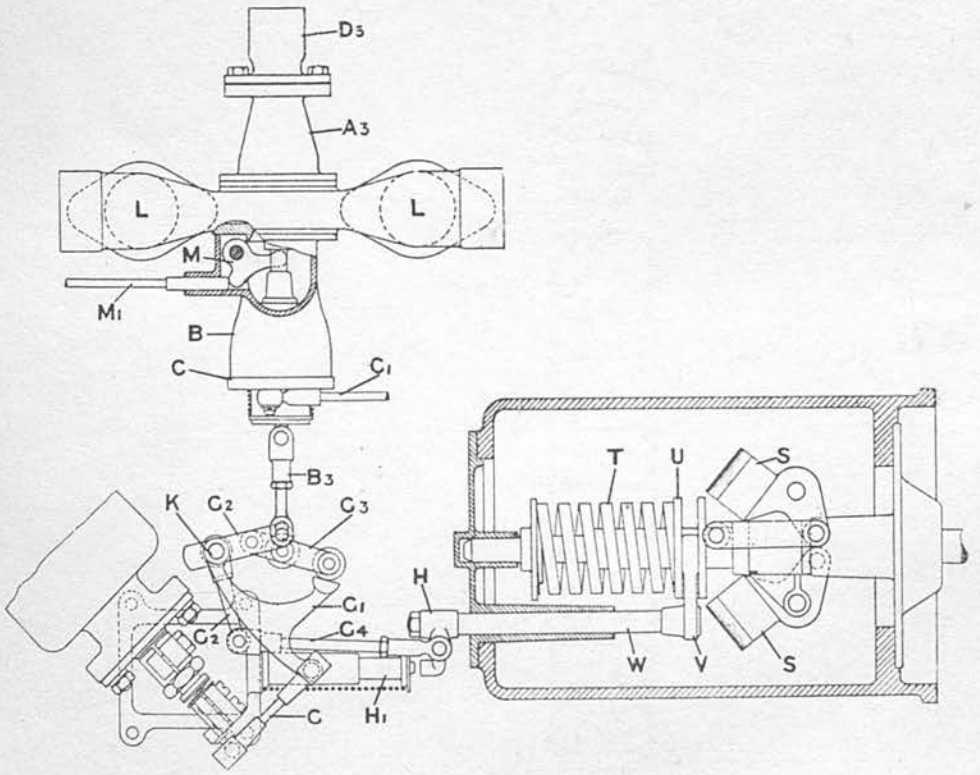


Fig. 18.

Arrangement of A 6 Murray Albion Governor, showing Carburettor Control and Ignition Advance Gear H.

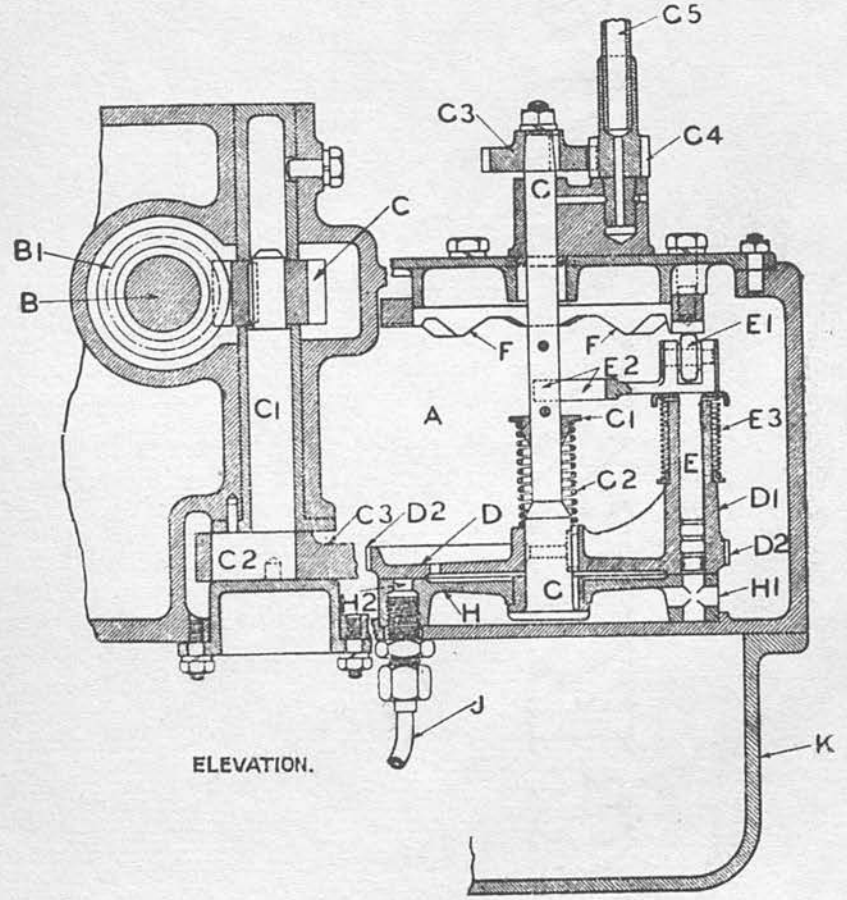


Fig. 19.

Sectional Elevation of Murray Albion Lubricator,
3-ton War Department Model.

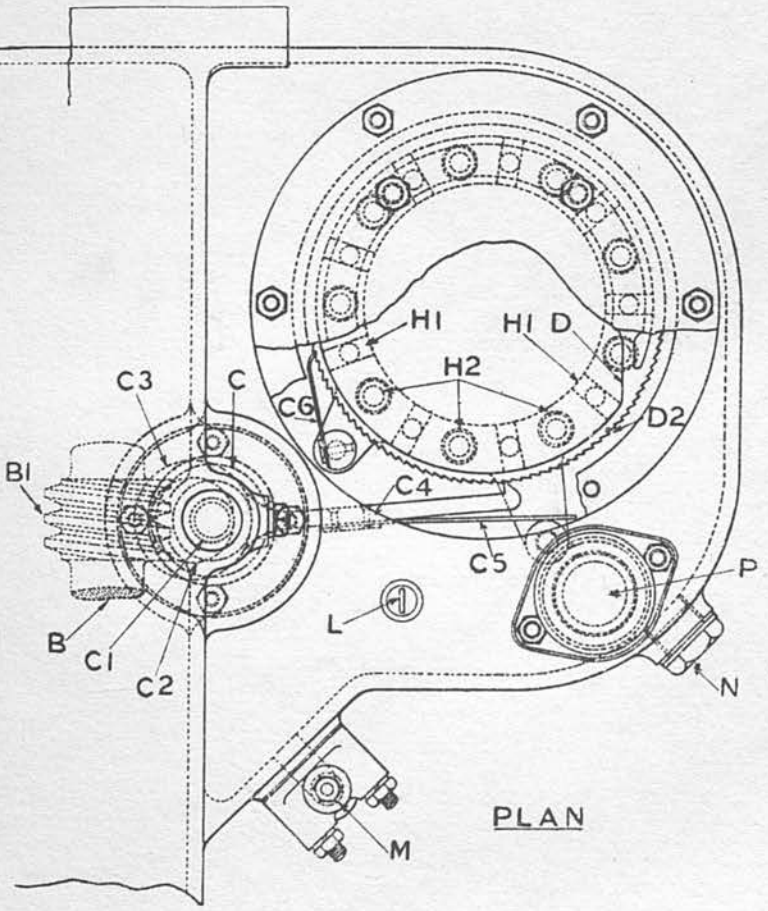


Fig. 20.

Plan of Murray Albion Lubricator, 3-ton
War Department Model.

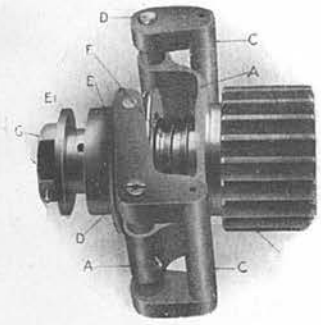


Fig. 21.
A 10 Type, Murray-Albion Governor.

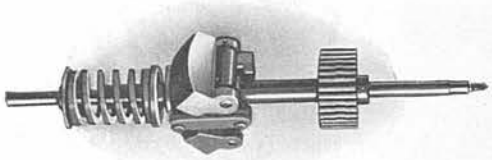


Fig. 22.
A 6 Type, Murray-Albion Governor.

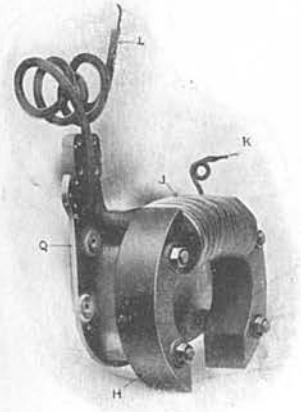


Fig. 23.
A 6 Armature Murray-Albion Magneto.

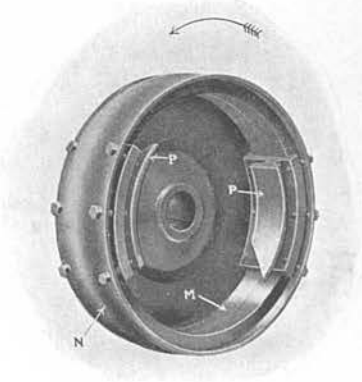


Fig. 24.
A 6 Field Magnets, showing Bevelled Pole Tips.

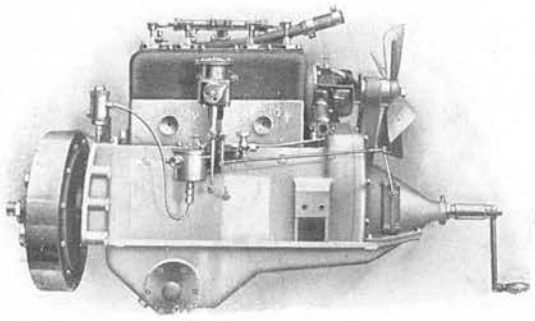


Fig. 25.
15 hp. Albion Engine, Carburettor Side.

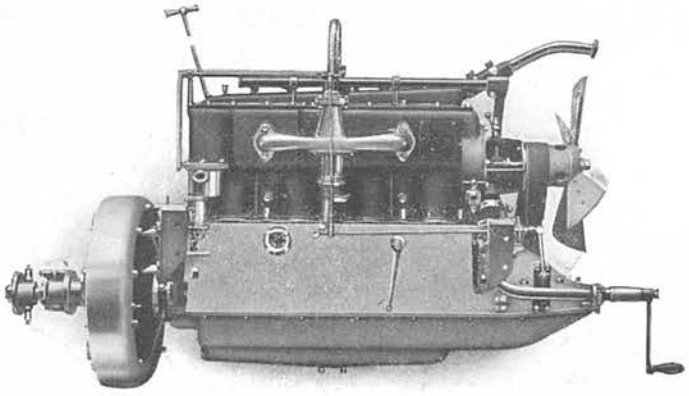


Fig. 26.
32 hp. Albion Engine, W.D. Type, Carburettor Side.

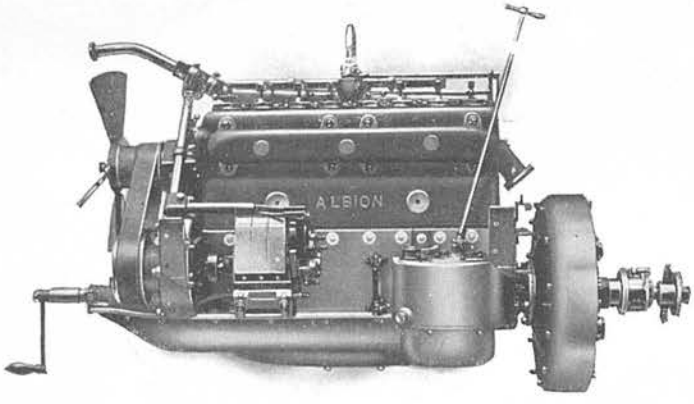


Fig. 27.
32 hp. Albion Engine, W.D. Type, Magneto and Lubricator Side.

SCHEDULE OF PATENT SPECIFICATIONS.

Official No.	Year.	SHORT TITLE.	No. in Schedule.
22351	1891	Hydraulic Speed Governors	1
23418	1897	Electric Motors and Dynamos	2
9251	1902	Apparatus for Governing I.C. Engines	3
14732	1902	Magneto-electric Generators or Dynamos	4
11880	1904	Magneto-electric Generators	5
14737	1906	Magneto-electric Generators	6
27570	1906	Magneto-electric Generators for I.C. Motors	7
5155	1907	Magneto-electric Generators	8
13034	1904	Carburettors for I.C. Motors	9
28362	1904	Carburettors for I.C. Motors	10
14198	1908	Carburettors for I.C. Engines	11
15584	1910	Carburettors for I.C. Engines	12
27073	1911	Carburettors for I.C. Engines	13
20980	1913	Paraffin Carburettor for I.C. Engines	14
13210	1904	Mechanical Feed Lubricators	15
7078	1905	Mechanical Feed Lubricators	16
23469	1905	Improved Flexible Coupling	17
26560	1905	Friction Clutches	18
7848	1906	Friction Clutches	19
17511	1910	Plate Friction Clutch	20
18837	1911	Plate Friction Clutches	21
3098	1915	Disengaging Gear for Friction Clutches	22
3099	1915	Plate Friction Clutches	23
23082	1908	Valves and Valve Gear for I.C. Engines	24
24705	1911	Valves and Valve Gear for I.C. Engines	25
1429	1912	Piston Valve I.C. Engines	26
15026	1909	Two-stroke cycle I.C. Engines	27
2060	1911	Two-stroke I.C. Engines	28
13915	1911	Two-stroke I.C. Engines	29
2252	1914	Two-stroke I.C. Engines	30
19151	1909	Means for Driving Cam Shafts in I.C. Engines	31
20277	1910	Cooling Arrangements for I.C. Engines	32
11878	1914	Improved Friction Drive	33
2800	1915	Friction Drive for Magneto Lighter	34
11139	1915	Switch Device for Car Lighting	35
101243		Electric Car Lighting	36
102121	1916	Governor for I.C. Engines	37

N° 22,351 A.D. 1891

Date of Application, 22nd Dec., 1891—Accepted, 23rd Jan., 1892

COMPLETE SPECIFICATION.

Improvements in Hydraulic Speed Governors.

THOMAS BLACKWOOD MURRAY Bachelor of Science, Electrical Engineer, Heavyside, Biggar, Lanarkshire, N.B. do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in hydraulic governors for automatically regulating the supply of fluid to any motor to which this governor is applied, so as to maintain a constant speed under varying loads, and more particularly to the government of turbine water wheels.

My invention consists in combining a high-speed centrifugal governor, driven by the motor to be governed, which governor operates a four-way water valve constructed according to my invention as herein described. This water valve controls the position of a piston which traverses a cylinder, called the regulating cylinder; the position of this piston regulating the flow of fluid into the motor. This four way valve is a piston valve with supply & escape ports, and also ports communicating with the top and also with the bottom of the regulating cylinder. When the speed rises above, or falls below the normal, the piston in the four way water valve falls or rises by the action of the centrifugal governor, and admits fluid under pressure to the bottom or top of the regulating cylinder; and opens the top or bottom of the regulating cylinder to the escape ports for a time sufficient to control the motor when the load varies; but when the load is constant, the four-way valve shuts off the pressure, and opens both top & bottom of regulating cylinder slightly to the escape ports.

The four way valve admits the fluid under pressure to the regulating cylinder, and opens the escape from the said cylinder, without any mechanical shocks or pressures on the said valve itself, so that there are no disturbing effects on the centrifugal governor. This portion of my invention is effected by placing the inlet ports of the four way valve diametrically opposite the ports communicating with the top and bottom of the regulating cylinder, so that the fluid passes freely through the valve with an even pressure, without acting on the valve; the passage in the valve is an annular space cut in the piston of the valve, so that the fluid flows in a plane perpendicular to the motion of the valve.

In order to enable others skilled in the art to which my invention relates, to understand and put my improvements into practice I have appended hereunto explanatory sheets of drawings.

Fig. I is a diametrical sectional elevation of the four-way valve through the line *g. h.* in Fig. IV.

Fig. II is a diametrical sectional elevation of the four way valve through the line *i. j.* in Fig. IV.

Fig. III is a diametrical sectional elevation of the four way valve cylinder through the line *g. h.* in Fig. IV, with the piston and the sleeve removed.

Fig. IV is a sectional plan of the four way valve through the line *c. d.* in Fig. I.

Fig. V is a sectional plan of the four way valve through the line *a. b.* in Fig. I.

Fig. VI is a sectional plan of the four way valve through the line *e. f.* in Fig. I.

Fig. VII is a sketch of the whole combination.

A is a metal cylinder which forms the outer casing of the four way valve, and in which are cut or cast the ports:—

S, the supply port.

E, the escape port.

[*Price 8d.*]

T, the port communicating with the top of the regulating cylinder.

B, the port communicating with the bottom, of the regulating cylinder.

D is a sleeve accurately turned and bored, and fitted inside cylinder A, with rectangular ports accurately cut in it; five of them forming the communication between the supply port S and the annular passage C in the piston of the valve as shown in Figs. I & IV. Five of them form the communication between the port T and the inside of the valve, and other five form the communication between the port B and the inside of the valve, as shown in Figs. I and V. Another port forms the communication between the escape port E and the inside of the valve as shown in Figs. I, II & VI.

P is a piston which is turned an easy fit for the sleeve D. Its length is a little less than the distance between the outside edges of the top and bottom ports T and B, as shown in Fig. I. To the end of the piston rod is attached a beam M by means of two links L Fig. II. The one end of this beam is linked to the centrifugal governor and the other end is pivoted to the rod R which can be raised or lowered by the nuts N so as to adjust the position of the piston in the four-way valve, as shown in Fig. II. Four ports H, H, are bored through the piston so as to allow free passage of fluid discharged above the piston to escape port E as shown in Figs. I, II, IV & V. C is an annular passage turned in the face of the piston (Figs. I, II & IV). Its breadth is a little less than the distance between the inside edges of the top and bottom ports T & B so that when the piston of the four way valve is in the central position, the top and bottom ports T and B are closed to supply but opened slightly to escape; and also when the piston is raised or lowered from this position the bottom or top ports are opened freely to escape, before the top or bottom ports are opened to supply. The annular passage C is made shallow so as to cause a uniform current, and therefore a uniform distribution of pressure on its bounding surfaces. The four holes H, H, in the piston P may be replaced by a port in the casing of the valve connecting the top and bottom of the valve.

In Fig. VII G. is a high-speed centrifugal governor, driven by the motor to be governed. As the speed rises, the rod F is pushed down. This rod F is linked to the beam M so that when the speed rises, the piston in the four-way valve is lowered. The supply port S is attached to some convenient head of water. K is the regulating cylinder from the top and bottom of which are pipes communicating respectively with the ports T and B in the four way valve. V is the piston in the regulating cylinder which decreases the supply of fluid to the motor when it is raised in the cylinder and conversely.

The piston in the four way valve is so adjusted that when the speed is normal it occupies a central position in the valve. When the speed rises the rod F is depressed and this depresses the piston in the four way valve and opens port B to the supply, and opens port T to the escape, thus causing piston V to rise and cut off a part of the supply to the motor until the speed again becomes normal. When the speed falls below the normal, T is opened to supply and B to escape thus causing the piston V to fall and increase the supply to the motor until the speed becomes normal.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

1. The combination of a high speed centrifugal governor with a four-way valve and a regulating cylinder, as and for the purposes herein described and illustrated by the accompanying drawings.

2. In a four-way valve a piston, having an annular passage for the fluid under pressure, and passages for the escape fluid, directing the fluid under pressure to the top or bottom of a regulating cylinder, and controlling the escape of fluid from the said cylinder, substantially as and for the purposes hereinbefore described and illustrated on accompanying sheets of drawings.

3. In a piston four-way valve as herein described an annular passage for the fluid under pressure flowing therein without exerting any unbalanced pressures parallel to the axis of the piston, as and for the purposes herein described and illustrated by the accompanying sheets of drawings.

Dated this 19th day of December 1891.

THOMAS BLACKWOOD MURRAY.

London: Printed for Her Majesty's Stationery Office, by Darling & Son, Ltd.—1892

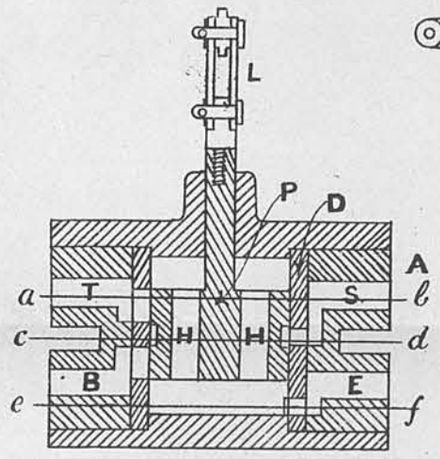


FIG I

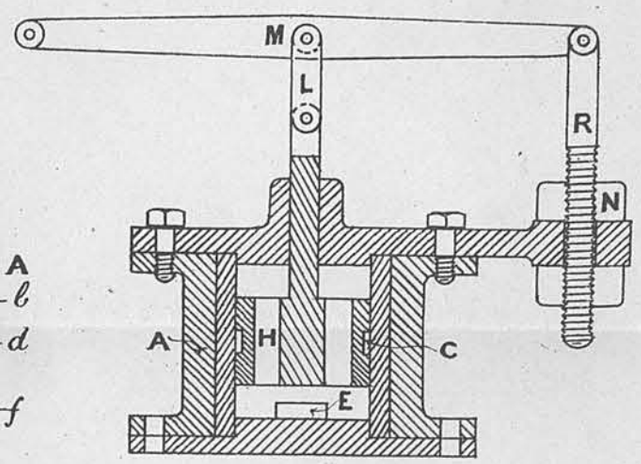


FIG II

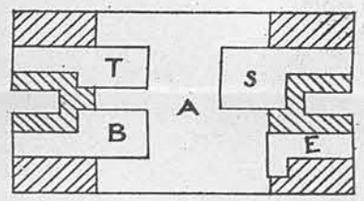


FIG III

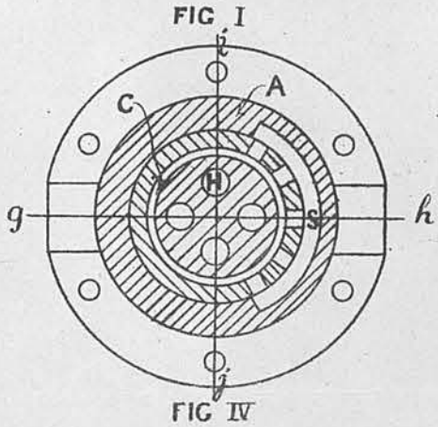


FIG IV

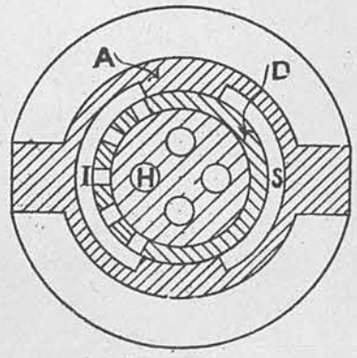


FIG V

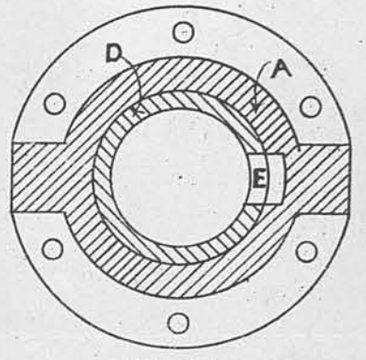


FIG VI

Malby & Sons, Photo-Litho.

London: Printed by Darling and Son Ltd.
for Her Majesty's Stationery Office. 1892.

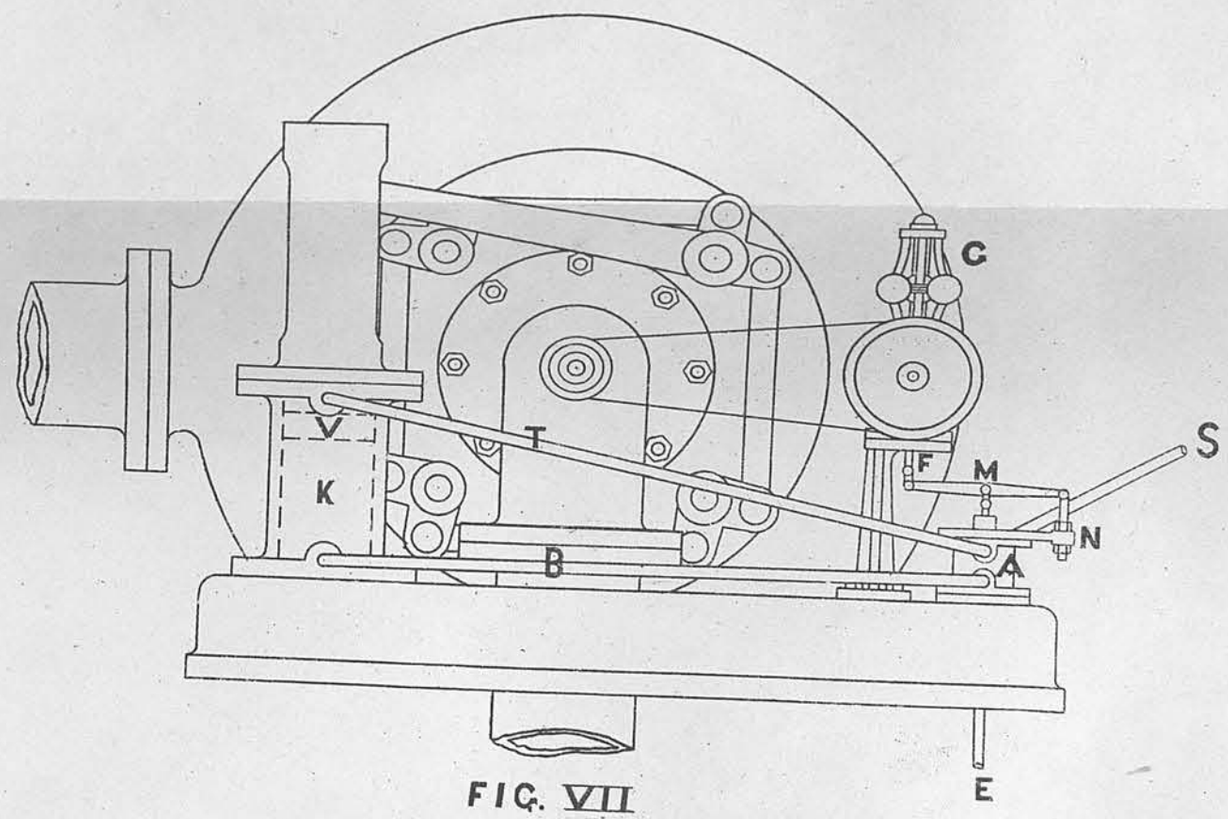


FIG. VII

A.D. 1891. Dec. 22. N° 22,351.
MURRAY'S Complete Specification.

[Third Edition.]

N° 23,418 A.D. 1897

Date of Application, 12th Oct., 1897—Accepted, 27th Nov., 1897

COMPLETE SPECIFICATION.

Improvements in Electro Motors and Dynamos.

We, THOMAS BLACKWOOD MURRAY, of 94, Hope Street, in the County of Glasgow, North Britain, Electrician, and GEORGE JOHNSTON, of the same place, Consulting Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, that is to say:—

This Invention has for its object to construct an electro motor which may be economically and efficiently worked at widely varying speeds and loads whilst being supplied with continuous current at approximately constant pressure, and one in which no adjustment of the brushes is required for different speeds and loads. A part of the improvements is also applicable to dynamos.

The improved motor is constructed with two armatures on the shaft, and each armature is provided with one or more separate and distinct windings connected up to their respective commutators. These windings may be of any suitable ring or drum type; and by connecting up the armature windings in series or in parallel combinations, lower or higher speeds can be obtained.

By varying the strength of the magnetic field by means of suitable resistances or other known means, the speed of the armatures can be varied within wide limits. In ordinary conditions this method is not admissable as it weakens or destroys the magnetic field necessary for the sparkless commutation of the armature currents, thereby preventing the satisfactory working of the motor. We avoid the difficulty referred to as occurring with ordinary arrangements by providing a separate field for reversing or commutating such field being practically independent of the main magnetic field, upon which the speed of the motor depends. Such separate field is much more conveniently, economically, and advantageously applied with the two armatures on one shaft than can be done with a single armature.

And in order that the Invention and the manner of performing the same may be properly understood we hereunto appended a sheet of explanatory drawings comprising diagrams showing examples of the improved arrangements.

Figures, 1, 2, and 3, of the drawings are a plan, a side elevation, and an end elevation of one example; and Figures, 4, and 5, are side and end elevations of another example. In these diagrams the reference letters, N, and S, denote, as usual the northward and southward poles of the several field electro magnets, and other letters are severally used to mark the same or like parts wherever they are repeated.

In the example shown in Figures, 1, 2, and 3, the shaft, A, has two armatures, B, C, and there are two main field magnets, D, E, each of which acts by its opposite poles, N, S, on the two armatures being arranged so that the N. pole of each magnet is on the side of the armature opposite to that acted on by the S pole of the other magnet. These main field magnets, D, E, are not shown in Figure, 1.

Separate comparatively small electro magnets, F, G, are placed so that their poles may act in the spaces through which the parts of the armatures successively

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PRICE 6d.

pass from the pole of one main magnet to that of the other, the N and S poles of these separate magnets being placed as shown in the diagrams to suit the direction of rotation indicated by the arrows. The separate magnets, F, G, are preferably energised by coils through which current passes to the armatures.

With ring armature winding two reversing magnets, F, G, are required; but with drum winding it is only necessary to use one.

The improvements are also applicable to multipolar machines; Figures, 4, and 5, showing the application to an electro motor with four main field magnets.

The additional small magnets (F, G) may also be applied to a dynamo to ensure sparkless reversal.

Having now particularly described and ascertained the nature of the said Invention and in what manner the same is to be performed, we declare that what we claim is:—

In electro motors and dynamos, the combination of two armatures on a shaft, with main field magnets each acting with its opposite poles on the two armatures, respectively, and with additional small magnets each acting similarly and in the spaces between the poles of the main magnets,—substantially as and for the purposes hereinbefore described.

Dated this Eleventh day of October 1897.

EDMUND HUNT,
Applicants' Agent.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 42—50/12/1911.]

A.D. 1897. Oct. 12. N° 23,418.

MURRAY & *another's* COMPLETE SPECIFICATION.

(1 SHEET)

(3rd Edition)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1

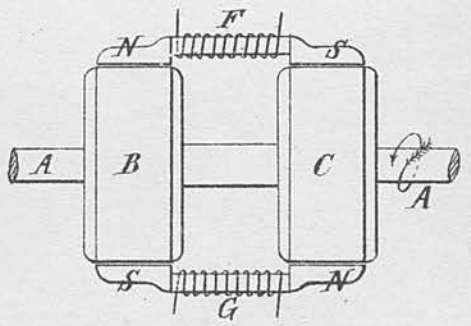


FIG. 2

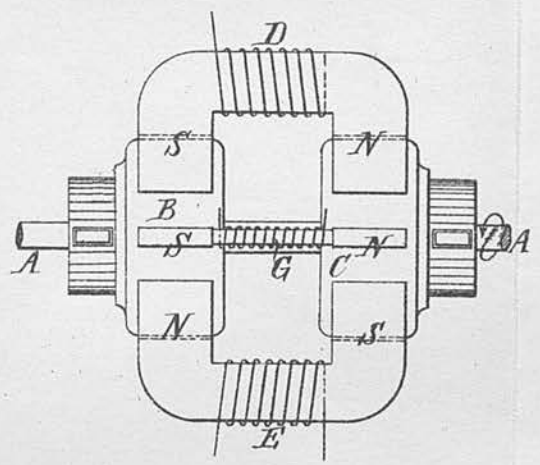


FIG. 3

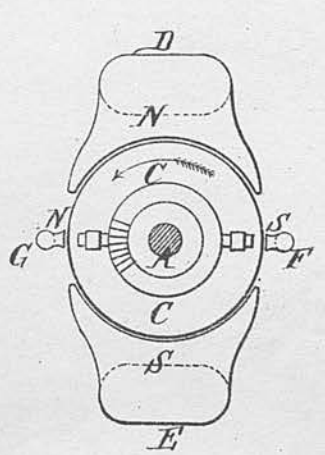


FIG. 4

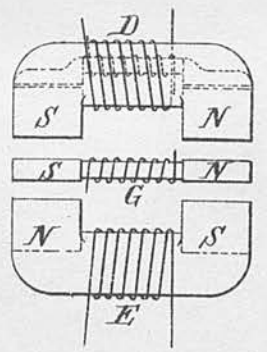
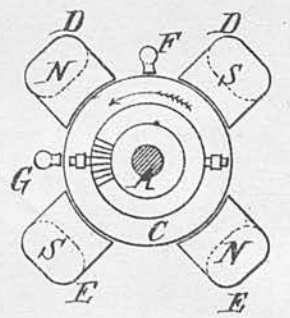


FIG. 5.



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[Second Edition.]

N° 9251 A.D. 1902

Date of Application, 22nd Apr., 1902

Complete Specification Left, 21st Jan., 1903—Accepted, 12th Mar., 1903

PROVISIONAL SPECIFICATION.

"Improved Method of and Apparatus for Governing and Varying the Speed of Internal Combustion Engines."

We, THOMAS BLACKWOOD MURRAY, and NORMAN OSBORNE FULTON, both of the Albion Motor Car Company, of 169, Finnieston Street, in the County of Glasgow, North Britain, Engineers, do hereby declare the nature of this invention to be as follows, that is to say:—

The said invention relates to internal combustion engines which may be used for various purposes but which are especially intended for the propulsion of motor cars, launches, air ships and the like; and has for its object to improve the method of and apparatus for governing and varying the speed of such engines (which are not as a rule self-starting) whereby the motor can be run at a comparatively slow speed during a halt, the speed fixed on being under the control of the governor used; and again when doing work, the desired full variation of higher speed is also under control.

In carrying out the invention the speed of the motor is regulated by reducing or increasing the quantity of the ingoing charge of combustible fluid. This may be effected by means of a simple throttle valve or a balanced valve or by varying the pressure on self-acting inlet valves arranged so that when the governor acts owing to an increase of speed, above the normal desired for the time being, the ingoing charge is more or less reduced thereby checking the speed of the engine. The governor used is preferably of the centrifugal type and is so arranged that at low speeds the centrifugal pull of the balls acts against a comparatively light spring forming part of the connecting gear between the governor and the throttle valve or the like. At the higher speeds the balls or centrifugal weights act against a comparatively stiff controlling spring in the connecting gear. There may be any desired number of springs arranged so that the governor will act through them in turn at the desired different ranges of speed, or instead of two or more springs a single or double conical spring may be employed. In order that the governor may act at any selected portion of its range, we provide means of varying the connecting gear between the governor and the throttling apparatus. This may be done by introducing a wedge piece into the connecting gear in such a manner that when the wedge is fully inserted a small outward radial motion of the balls suffices to move the lighter of the two springs and through it the connecting gear so as almost to cut off the charge consequently compelling the engine to keep to the low range of speed. As the wedge is withdrawn the balls will require to travel further out before the controlling gear will be moved sufficiently to actuate the throttle valve; and if they travel far enough out to come under the influence of the stronger of the two springs before governing, the engine will then be running at the considerably increased speed. The distance through which the governor travels may be made several times as great as that through which the throttling apparatus moves from full open to shut so that a variety of governed speeds are provided, the one for the time being depending on the position of the wedge.

According to a second modification instead of a wedge being introduced into

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or withdrawn from the connecting gear in order that the governor may act at the selected speed, the governor may be arranged to act on one end of a lever by the other end of which the throttling arrangements are actuated provision being made to have the position of the fulcrum of this lever adjustable in such a way that the relative positions of the governing and throttling apparatus may be suitably fixed in order to accomplish the above described functions.

Dated this Twenty first day of April 1902.

EDMUND HUNT.
Applicants' Agent.

COMPLETE SPECIFICATION.

"Improved Method of and Apparatus for Governing and Varying the Speed of Internal Combustion Engines."

We, THOMAS BLACKWOOD MURRAY, and NORMAN OSBORNE FULTON, both of the Albion Motor Car Company, of 169, Finnieston Street, in the County of Glasgow, North Britain, Engineers, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—that is to say:—

The said invention relates to internal combustion engines which may be used for various purposes but which are especially intended for the propulsion of motor cars, launches, air ships and the like; and has for its object to improve the method of and apparatus for governing and varying the speed of such engines (which are not as a rule self-starting) whereby the motor can be run at a comparatively slow speed during a halt, the speed fixed on being under the control of the governor used; and again when doing work, the desired full variation of higher speed is also under control.

And in order that the said invention may be properly understood we hereunto append a sheet of explanatory drawings to be hereinafter referred to in describing the improvements.

Figure 1, of the drawings is a side elevation partly in section of the improved governing mechanism. Figure 2, is a similar view of a modification of the improvements. Figure 3, is a front elevation and Figure 4 a cross section of another modification In these drawings the same reference letters and numerals are used to mark the same or like parts.

According to the invention as shown in Figures 1, 2, 3, and 4, the speed of the engine or motor is regulated by a governor preferably of the centrifugal type which is mounted on or driven from the motor shaft and is arranged to control a throttle valve of the balanced or rotatory type. The action of the governor is controlled preferably by two springs fitted to sleeves loose on the governor shaft and actuated by the governor, one of the sleeves being connected to a controlling lever acting on the throttle valve the position or extent of opening of which is regulated by a wedge, lever, or sleeve device.

In the example of the improved apparatus as shown in Figure 1, the governor crosshead, A, is keyed to the motor shaft, B, or to a shaft driven by the motor and has on it the usual weighted levers, A 1, A 2, the inner ends of which work between collars, C 1, C 2, on a comparatively long sliding sleeve, C, loose on the shaft, B. On the same sleeve, C, is another set of collars, C 3, C 4, between which works the lower end of a controlling lever, D, centred vertically on a fixed fulcrum pin, D 1, and having on its upper end a roller, D 2, bearing against a wedge shaped part, E 1, on a vertical valve shifting rod, E, connected to an operating handled lever, G, provided with a holding pin, G 1, working in a slot G 2,

in a fixed quadrant piece, G 3, the pin being furnished with an outer jam nut, G 4, to fix the handled lever in any desired position. The outer end of the throttle valve spindle, H, bears against the plain or straight side of the vertical rod, E, and on the back of the throttle valve, H 1, which is of the double-beat type arranged in a casing, H 3, there is fitted a controlling spring, H 2, which acts so as always to close the valve. On a reduced part, B 1, of the shaft, B, a shorter sliding sleeve, J, is loosely mounted, the shoulder or step, B 2, on the shaft forming a stop for the sleeve in one direction of its movement while a nut, B 3, on the shaft limits its travel in the opposite direction. A comparatively light spring, K, is arranged to act between the back of the innermost collar, C 4, on the long sleeve, C, and the face of the short sleeve, J, a similar but stronger spring, L, being also arranged to act between a flange or shoulder, J 1, on the short sleeve, J, and the nut stop, B 3, further secured by an outer jam nut, B 4.

When it is desired to govern the engine at a low speed the operating handle, G, is fixed in the quadrant slot, G 2, in or about the position shown, the wedge part, E 1, on the valve shifting rod, E, being thus inserted sufficiently between the bearing roller, D 2, and the valve spindle, H, so as to place the throttle valve, H 1, in its normal full-open position as shown. With this opening of valve the action of the governor is counteracted only by the light spring, K, as an outward motion of the governor balls, A 3, sufficient to move the sliding sleeve, C, up to touch the short sleeve, J, would be sufficient to completely close the throttle valve, consequently the engine would be governed within the range of the light spring. The throttle valve, H 1, is thus quickly and easily influenced by the centrifugal action of the governor balls, A 3, so that it is closed sufficiently so as to almost cut off the charge thereby compelling the engine to keep to the low range of speed. When it is desired however to govern at a full high speed the operating handle, G, is placed at the bottom of the quadrant slot, G 2, so that the valve is thus opened considerably beyond its normal full-open position owing to the wedge, E 1, having been fully inserted between the roller, D 2, and spindle, H,

With this opening of valve the governor balls, A 3, would then require to travel sufficiently far out to force the short sleeve, J, almost right up against the nut stop, B 3, before the valve would be closed, consequently the engine would govern at a much higher speed than formerly as the stronger spring, L, would thus come into play when the valve had moved back to about its normal full-open position. As in this position a greater centrifugal pull is required from the governor balls to overcome the pressure of the spring, L, consequently a higher speed is attained. The distance through which the governor balls, A 3, travel outwards is made several times as great as that through which the throttle valve, H 1, moves from full open to shut so that a variety of speeds is thus provided for, the one for the time being depending on the position of the wedge, E 1. The apparatus may be arranged so that the valve, H 1, will open when the wedge, E 1, is withdrawn instead of when it is inserted as hereinbefore described, and in some cases also more than two controlling springs may be employed for acting on the governor, or instead of two or more springs a single or double conical spring may be used.

According to the modification shown in Figure 2, the wedge and roller arrangement is dispensed with and a lever device arranged as follows is provided for opening the throttle valve, A valve shifting lever, E, is provided having its lower end jointed to the upper end of the controlling lever, D, the upper end of the shifting lever being connected to a link, M, coupled to an upwardly projecting bell crank arm, G 5, formed on the operating handled lever, G. The end of the throttle valve spindle, H, bears against the side of the shifting lever, E, and on the operating handle, G, being moved downwards as before, the shifting lever, is thus turned inwards so as to press against the spindle and thereby open the valve as required an opposite movement of the operating handle reversing the shifting lever and allowing the valve to close. By this means the throttle

valve, H 1, can be adjusted as before to any desired position and when the operating handle, G, is set in position for working the engine the controlling lever, D, also similarly moves the shifting lever, E, so as to adjust the throttle valve to suit the speed required.

In the modification shown in Figures 3, and 4, a rotatory throttle valve, H 1, is employed the valve rotating within a sleeve, E 2, arranged to turn in the valve casing, H 3, by means of the operating handle, G, as shown in Figure 3, the valve being connected to the upper end of the controlling lever, D, by a lever and link attachment, M. The valve, H 1, and sleeve, E 2, are each provided with two inlet ports, N, P, the valve ports, N, being much wider than those in the sleeve, the position of which determines the travel the governor must make before commencing to throttle the charge. The valve is opened by turning the sleeve, E 2, clockwise, and when the sleeve is set as shown with its ports, P, opposite the ends of the valve ports, N, the valve is then in its normal full-open position, thereby enabling the engine to be governed at the low speed the controlling lever, D, through its connection, M, acting on the valve so as to suitably close the sleeve ports, P, and give the reduced charge as required. When the sleeve ports, P, are turned to the other ends of the valve ports, N, the apparatus is then arranged for governing at the full high speed as the valve has thus farther to travel before closing so that the stronger spring, L, will accordingly come into action, as described in connection with Figure 1, thereby enabling the increased speed to be maintained as required.

According to another modification (not shown) the speed of the engine may be regulated by varying the pressure on what are known as self-acting inlet valves arranged so that when the governor acts owing to an increase of speed above the normal desired for the time being, the ingoing charge is more or less reduced thereby checking the speed of the engine.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1—In apparatus for governing and varying the speed of internal combustion engines, a governor with one or more controlling springs actuating a throttle or other inlet valve through a part or parts variable as to position by means of an operating handle, substantially as and for the purposes hereinbefore described.

—2—In apparatus for governing and varying the speed of internal combustion engines, a spring controlled governor of wide range actuating a throttle or other inlet valve of short range through mechanism controlled by an operating handle and capable of varying the relative position of the valve and the governor, substantially as and for the purposes hereinbefore described.

—3—In apparatus for governing and varying the speed of internal combustion engines, a centrifugal governor arranged on or driven from the engine shaft, sliding sleeves on the shaft actuated by the governor and furnished with controlling springs, a controlling lever centered on the framing and connected to one of the sliding sleeves and actuating a throttle or other inlet valve spindle through a wedge interposed between the lever and the end of the spindle, the wedge being on a rod connected to an operating handle, substantially as and for the purposes hereinbefore described.

—4—In mechanism forming the subject matter of Claim, 3, employing a lever or link for acting on the valve spindle instead of a wedge, the lever bearing against the end of the spindle and being connected at one end to the controlling lever and at the other end to a link coupled to a bell-crank arm on the operating handle, substantially as and for the purposes hereinbefore described.

Dated this Twentieth day of January, 1903.—

EDMUND HUNT & Co.
121 West George St., Glasgow.
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[G. 8266—50—10/1904.]

(2nd Edition)

FIG. 1.

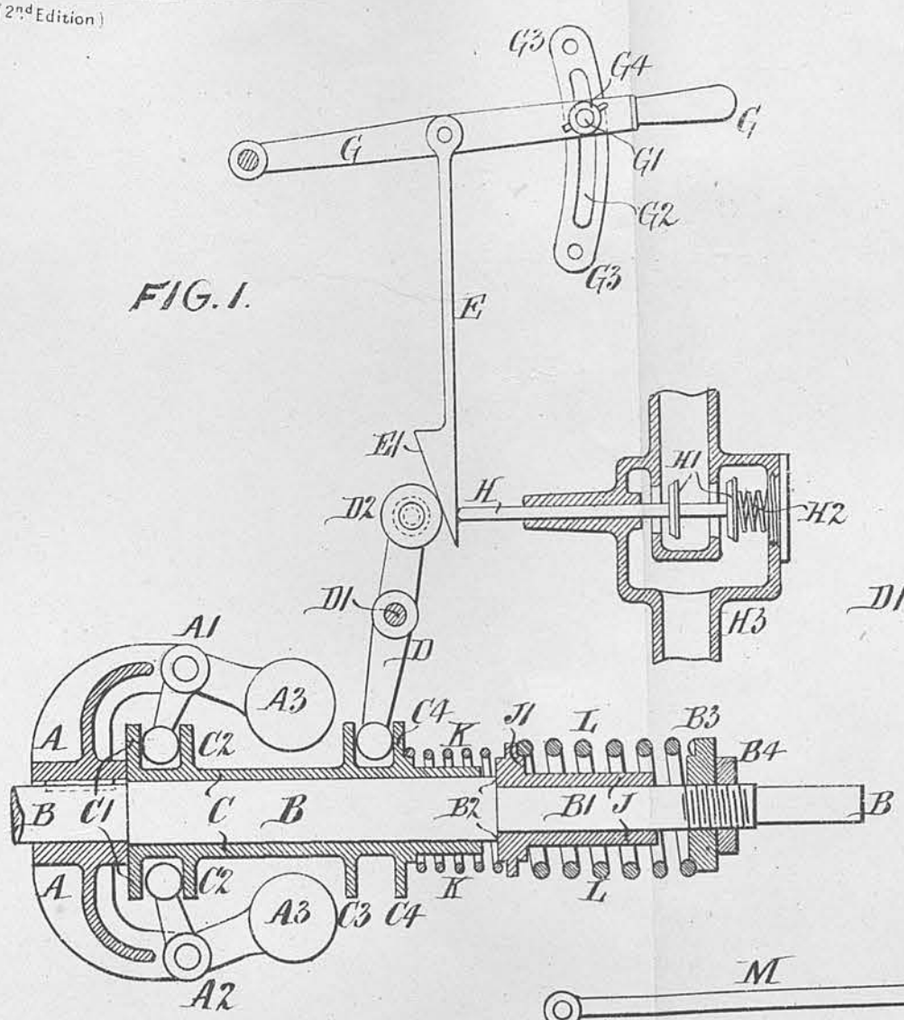


FIG. 3.

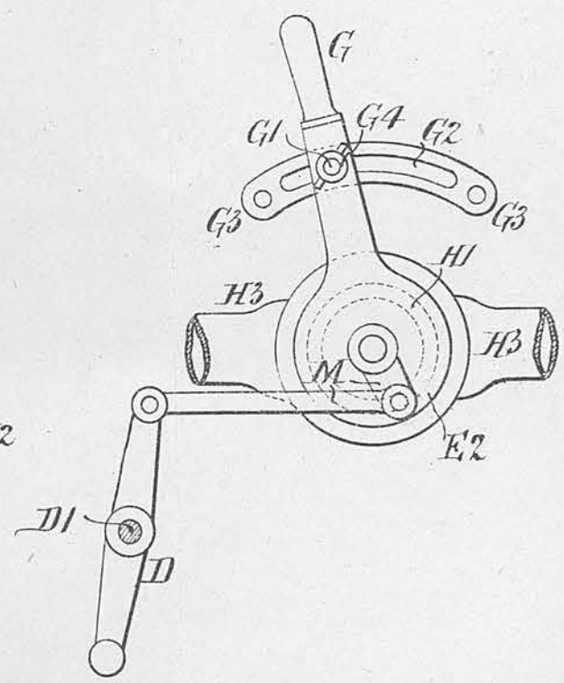


FIG. 4.

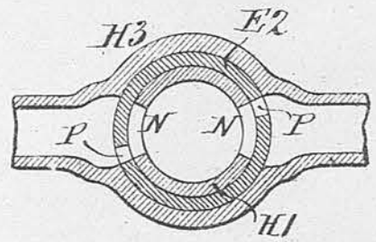
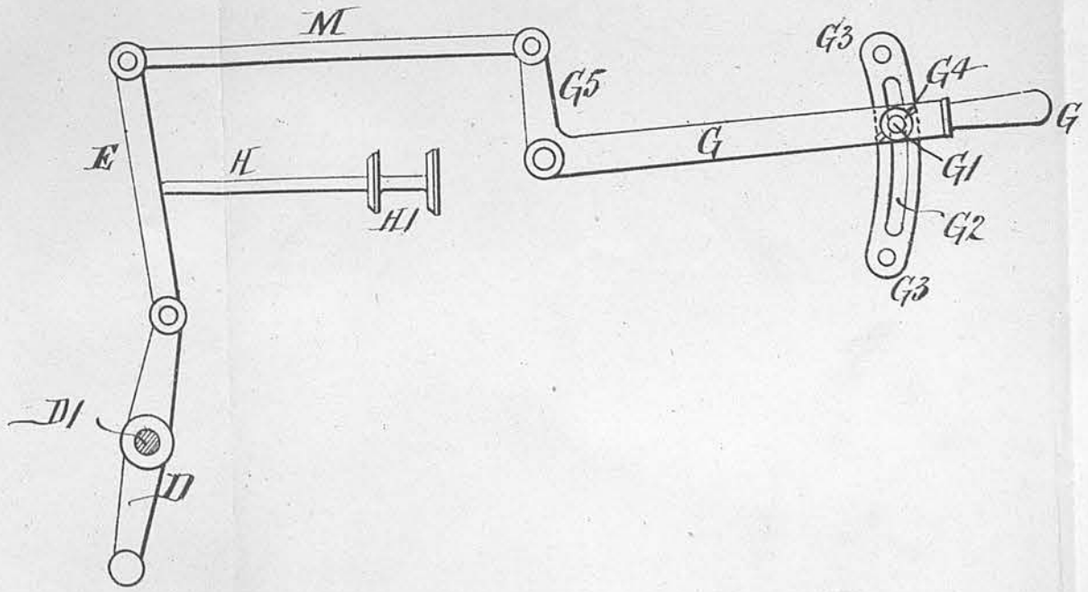


FIG. 2.



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Malby & Sons, Photo-Litho.

[Second Edition.]

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N° 14,732 A.D. 1902

Date of Application, 2nd July, 1902
Complete Specification Left, 21st Mar., 1903—Accepted, 14th May, 1903

PROVISIONAL SPECIFICATION.

'Improvements in Magneto Electric Generators or Dynamos.''

We, THOMAS BLACKWOOD MURRAY, and NORMAN OSBORNE FULTON, both of the Albion Motor Car Company, Limited, of 169, Finnieston Street, in the County of Glasgow, North Britain, Engineers, do hereby declare the nature of this invention to be as follows, that is to say:

This invention has for its object to improve the form of the fixed armature for magnets electric generators or dynamos, especially those used for generating electric current for ignition in internal combustion engines so that whilst such armature is extremely simple and compact it can be easily removed for inspection without disturbing the driving shaft of the engine.

In carrying out the invention the armature used is of the single coil two pole kind working with a two pole rotating field; either permanent magnets or electro magnets being used for the field. The armature is of a ring shape with a portion on one side cut away and a portion on the other side reduced to take the winding which embraces this reduced portion of the ring. The armature ring may be one piece of iron or may be laminated and if desired the armature core may be divided at the reduced portion so that the coil after it has been wound on a spool can be placed in position on the reduced portion. The magnetic flux is alternately through the coil in one direction and then in the other as the field rotates. The armature is fixed to the frame work of the machine or in the case of application to internal combustion engines to the frame work of the engine and the shaft passes concentrically through the armature, and the pole pieces are carried concentrically with the shaft and keyed to it on a suitable "spider" or carrying frame of non-magnetic material. Where the permanent magnets are used to produce the magnetic flow they may be fixed to the pole pieces or carried in any other suitable way or the pole pieces may be magnetised by a coil through which continuous current is flowing. When the shaft is rotated the magnetic flux passes from the one pole of the armature through the core of the coil to the other pole of the armature in alternate directions as usual. The current generated thereby may be lead from the coil in any desired manner.

Dated this First day of July, 1902.—

EDMUND HUNT.
Applicants' Agent.

COMPLETE SPECIFICATION.

Improvements in Magneto Electric Generators or Dynamos.''

We, THOMAS BLACKWOOD MURRAY, and NORMAN OSBORNE FULTON, both of the Albion Motor Car Company, Limited, of 169 Finnieston Street, in the

[*Price 8d.*]

County of Glasgow, North Britain, Engineers, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—that is to say : —

This invention has for its object to improve the form of the fixed or stationary armature for magneto electric generators or dynamos, especially those used for generating electric current for ignition of charges in internal combustion engines, so that whilst such armature is extremely simple and compact it can be easily removed for inspection without disturbing the driving shaft of the engine.

In carrying out the invention the armature used is of the single coil two pole kind working with a two pole rotating field; either permanent magnets or electro magnets being used for the field. The armature is of a ring shape with a portion on one side cut away and a portion on the other side reduced to take the winding which embraces this reduced portion of the ring. The armature ring may be of one piece of iron or it may be laminated, and if desired the armature core may be divided at the reduced portion so that the coil after it has been wound on a spool can be placed in position on the reduced portion. The magnetic flux is alternately through the coil in one direction and then in the other as the field rotates. The armature is fixed to the frame work of the machine, or in the case of application to internal combustion engines to the frame work of the engine, and the shaft passes concentrically through the armature. The pole pieces are carried concentrically with the shaft and keyed to it on a suitable "spider" or carrying frame of non-magnetic material. Where permanent magnets are used to produce the magnetic flow they may be fixed to the pole pieces, or carried in any other suitable way, or the pole pieces may be magnetised by a coil through which continuous current is flowing. When the shaft is rotating the magnetic flux passes from one pole of the armature through the core of the coil to the other pole of the armature in alternate directions as usual. The current generated thereby may be led from the coil in any desired manner.

In order that our said invention and the manner of performing the same may be properly understood we hereunto append a sheet of explanatory drawings to be hereinafter referred to in describing one modification of our improvements by way of example, and throughout which drawings like reference letters indicate similar parts.

Figure 1, on the accompanying sheet of drawings is a sectional side elevation and Figure 2, an end elevation of the generator complete, Figure 3, being a plan, and Figures 4, and 5, elevations at right angles to each other of the improved form of stationary armature.

As shown in the drawings the armature, A, is ring-shaped and is of the single coil two pole type, being preferably built up of soft iron laminations bolted together by insulated bolts, B, which bolts may, as shown, be used to fix the armature to the framework, C, of the machine, or in the case of application to an internal combustion engine to the framework of the engine, in such a position that the external surfaces of the armature are concentric with the shaft, D, which carries the field magnets, hereinafter described, and which shaft in the case of internal combustion engines may be a portion of the crank shaft of the motor. If desired the armature, A, instead of being laminated, may be made of one piece of iron. One portion of the armature ring, A, is entirely cut away, leaving a gap, E, and the portion diametrically opposite this is reduced or so shaped as to take the armature winding, F, which embraces this reduced portion of the ring. This winding may consist, as shown of one or more coils of insulated wire wound round this portion of the armature. If preferred, the armature ring, A, may be divided at the reduced portion so that the coil after it has been wound on a spool can be placed in position on the reduced portion. The design of the field magnets may be of any convenient type and they may

be energised either by permanent magnets or by a coil having a continuous current flowing in it. Figures, 1, and 2, show a convenient form of two pole field magnet arranged to rotate externally around the armature, the two pole pieces, G, being of soft steel or iron bolted to a non-magnetic spider, H, which in its turn is keyed to the shaft, D, and therefore rotates along with it, the usual clearance being left between the inner faces of the pole pieces, G, and the outside of the armature. To these pole pieces are fixed two permanent magnets, J, which consist, in this instance, of straight hardened and magnetised steel bars. The soft steel pole pieces, G, convey the magnetic flux from the magnets, J, to the armature, A, The angle subtended by the pole face, G, is approximately equal to the angle subtended by the gap, E, and the coil, F.

As the north and south pole pieces, G, of the field magnets, J, are always diametrically opposite and as there is the gap, E, in the armature ring, A, the magnetic flux must pass principally through the core of the coil, F, except when either pole piece, G, is directly over the coil, F, and as the field magnets, J, rotate it is evident that the magnetic flux passes from the one pole through the core of the coil, F, to the other pole of the armature in alternate directions as usual. Taking Figure 4, when the north pole is to the right of a vertical centre line the magnetic flux through the core of the coil, F, will pass from right to left and conversely when it is to the left of this vertical line, the magnetic flux will pass from left to right through the core of the coil, F. Consider Figure 2, assuming the north poles to be at the top as indicated by the letters, N, as the field magnets, J, rotate a few degrees in the direction of the arrow the magnetic flux through the core of the coil, F, will be from right to left, after the field magnets, J, have rotated a little more than 180 degrees this will be reversed and the flow will be from left to right through the core of the coil F, until the field magnets have rotated through another 180 degrees when it will once more be reversed. From this it is apparent that two reversals of the magnetic flux takes place per revolution, consequently an alternating current will be generated in the coil, F, by the rotation of the field magnets, J, round it, the frequency being equal to the number of revolutions per second. The current generated thereby may be led from the coil in any desired manner.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed we declare that what we claim is :—

1, The improved magneto electric generator or dynamo, substantially as hereinbefore described and as shown on the accompanying drawings.

2, In a magneto electric generator or dynamo, a two pole stationary ring armature made with a gap and so carried and arranged that its external surfaces are concentric with a rotating shaft, which it encircles, substantially as and for the purposes hereinbefore described.

3, In a magneto electric generator or dynamo, a two pole ring armature having a gap at one side and a portion opposite this gap to receive the winding, substantially as and for the purposes hereinbefore described.

Dated this Twentieth day of March 1903

EDMUND HUNT & Co.,
121 West George St., Glasgow.
Applicants' Agents.

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[Wt. 25—50/8/1907.]

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FIG. 1.

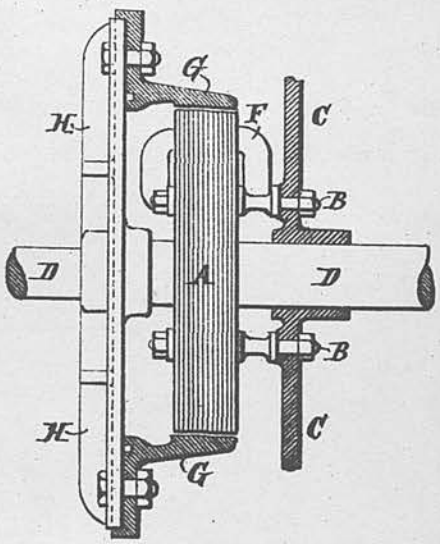


FIG. 2.

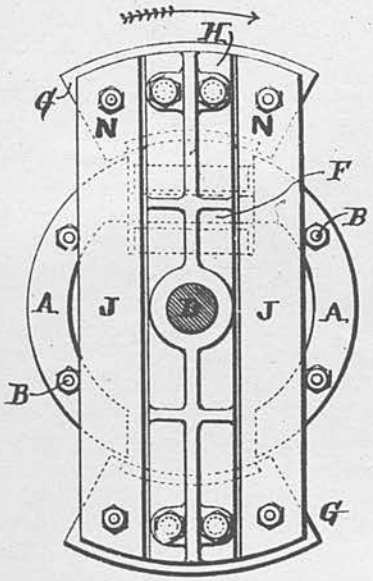


FIG. 3.

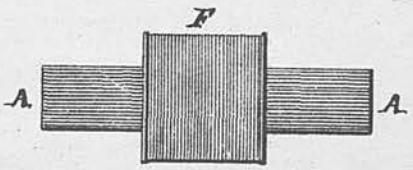


FIG. 4.

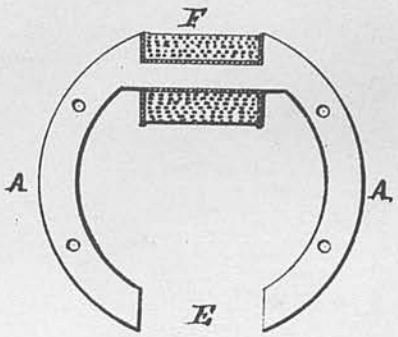
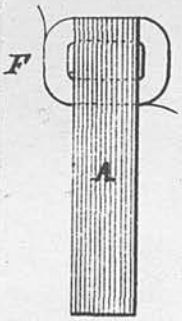


FIG. 5.



Malby & Sons, Photo-Litho.

[Second Edition.]

5.

N° 11,880 A.D. 1904

Date of Application, 25th May, 1904
Complete Specification Left, 21st Feb., 1905—Accepted, 13th Apr., 1905

PROVISIONAL SPECIFICATION.

"Improvements in Magneto-electric Generators".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, of the same place, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to magneto-electric generators, more particularly adapted for use in connection with internal combustion motors; and has for its object to improve and simplify the construction of such machines; to obviate the use of collector rings or the like; and, by avoiding the use of moving field magnets or of windings upon the rotor, to produce a machine, the rotatory member of which is more easily balanced with the accuracy requisite for running at a comparatively high speed.

In a magneto-electric generator made with our improvements, the armature and field magnets are stationary and a rotor is employed carrying two sets of inductors conveying the magnetic flux from the field-magnets through the armature alternately in opposite directions, thereby generating and alternating current in the armature winding.

The rotor consists of a wheel or spider of non-magnetic material, carrying upon each side a series of arch-shaped inductors, preferably built up of iron laminations. The inductors on opposite sides preferably alternate, that is to say, the centre of one inductor upon one side is opposite the centre of the gap between adjoining inductors upon the opposite side of the spider, and their outer surfaces are cylindrical.

The armature consists of a bar electro-magnet, the core of which is preferably built up of laminations which may be recessed to receive the winding. The armature is placed parallel, or nearly so, to the shaft carrying the rotor; and the length of the spool of completed winding upon it is made approximately equal to the axial distance between the two sets of inductors upon either side of the spider. The pole-faces of the armature are curved to the radius of the inductor cylinder and the armature is fixed as close to the faces of the inductors as mechanical clearance will admit of.

The magnetic field may be provided by either permanent or electro-magnets, the former being preferable when the generator is to be used in connection with internal combustion motors. The field magnets are provided with pole pieces, preferably laminated, similar in form to the armature core.

The armature is set between the pole pieces, the angular distance between it and the pole pieces depending upon the number of inductors in each set; while the pole pieces are set, similarly to the armature, as close to the faces of the inductors as the requisite mechanical clearance will permit.

When permanent magnets are used for the field, they may conveniently be of horse-shoe form and so designed as to produce the desired magnetic flux.

The circumferential length of each inductor is made approximately equal to the circumferential distance between the inner edges of the pole pieces of the field magnets, and the sets of inductors are equally spaced around the circumference of the spider, the gap between adjacent inductors being approximately equal to the circumferential length of the armature and field-magnet pole faces, and when the centre of an inductor in one set is

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under the centre of the armature pole face, the centre of the gap between the two nearest inductors in the other set is also under the centre of the armature pole face.

It is clear that the details of the invention may be greatly varied without departing from it, its essential element being the employment of an inductor-rotor carrying two sets of inductors upon its circumference and at opposite sides, and of stationary armature and field magnets; so that the rotatory member not carrying field magnets and owing to the absence of windings upon it, is more easily balanced and the necessity of collector rings or the like obviated; while the form, construction, and relative positions of armature, field-magnets, and their pole pieces and of inductors may be widely varied; for instance, in some cases, the inductors may be arranged around only part of the circumference of the rotor, non-magnetic balance weights being substituted for one or more of the inductors, or each set may be arranged upon a separate spider.

In an example of the carrying out of the invention, the armature, made of laminations provided with a recess to take the windings in the manner hereinbefore described, is carried in a casting of non-magnetic metal to which are also bolted, each at 60 degrees thereto, the pole pieces of the field magnets made in the manner hereinbefore described. The field magnets, which are of horse-shoe permanent type are secured to the pole pieces and encircle them and the armature. The casting carrying the armature, pole pieces, and field magnets is carried in close proximity to the rotor, only mechanical clearance being left between the faces of the pole pieces and armature and the circumference of the rotor.

The circumferential faces of the field magnet and armature poles are of a width equal to two-thirds of the distance between the edges of the adjacent poles, while the inductors are of a length equal to the distance between these adjacent edges of the field magnet poles, and otherwise dimensioned commensurately with the magnetic flux for which the machine is designed.

Three inductors made and set in the manner hereinbefore described form each set, and a set is carried upon each side of the rotor. It therefore follows that if an inductor of one set is in the best position for conveying the magnetic flux from one field pole piece to the one pole of the armature, an inductor in the other set will also be in the best position for conveying the magnetic flux from the other pole of the armature to the opposite field magnet pole piece. A rotation of the rotor, equal to the angle between one of the field magnet poles and the armature, will obviously give the position of maximum magnetic flow in the opposite direction. It is therefore evident that as the rotor rotates, the magnetic flux will be alternately in opposite directions, and the machine will have a number of alternations per revolution equal to the number of inductors in each set; that is to say that, with the present example, there are three complete alternations in the current generated in the armature coil for each complete revolution of the rotor, and six periods of maximum tension. Such an arrangement is particularly applicable in the case of internal combustion motors, as, with this number of alternations, the machine is capable of supplying current for the ignition of charges in motors having one, two, three, four six, nine, or twelve cylinders; a similar but less efficient machine having two inductors in each set being applicable to a one, two, four, or eight cylinder motor; or, if a non-magnetic balance weight be substituted for one of the inductors in one of the sets for a single cylinder motor, then forming an efficient machine.

Dated this Twenty fourth day of May 1904.

EDMUND HUNT & Co.,
Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

"Improvements in Magneto-electric Generators".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention relates to magneto-electric generators, more particularly adapted for use in connection with internal combustion motors; and has for its object to improve and simplify the construction of such machines; to obviate the use of collector rings or the like; and, by avoiding the use of moving field magnets or of windings upon the rotor, to produce a machine, the rotatory member of which is more easily balanced with the accuracy requisite for running at a comparatively high speed.

In a magneto-electric generator made with our improvements, the armature and field magnets are stationary and a rotor is employed carrying two sets of inductors in series in the same magnetic field and conveying the magnetic flux from the field magnets through the armature alternately in opposite directions thereby generating an alternating current in the armature winding.

The rotor consists of a wheel or spider of non-magnetic material, carrying upon each side a series of arch-shaped inductors, preferably built up of iron laminations. The inductors on opposite sides preferably alternate, that is to say, the centre of one inductor upon one side is opposite the centre of the gap between adjoining inductors upon the opposite side of the spider, and their outer surfaces are cylindrical.

The armature consists of a bar electro-magnet, the core of which is preferably built up of laminations which may be recessed to receive the winding. The armature is placed parallel, or nearly so, to the shaft carrying the rotor; and the length of the spool of completed winding upon it is made approximately equal to the axial distance between the two sets of inductors upon either side of the spider. The pole-faces of the armature are curved to the radius of the inductor cylinder and the armature is fixed as close to the faces of the inductors as mechanical clearance will admit of.

The magnetic field may be provided by either permanent or electro-magnets, the former being preferable when the generator is to be used in connection with internal combustion motors. The field magnets are provided with pole pieces, preferably laminated, similar in form to the armature core.

The armature is set between the pole pieces, the angular distance between it and the pole pieces depending upon the number of inductors in each set; while the pole pieces are set, similarly to the armature, as close to the faces of the inductors as the requisite mechanical clearance will permit.

When permanent magnets are used for the field, they may conveniently be of horse-shoe form and so designed as to produce the desired magnetic flux.

The circumferential length of each inductor is made approximately equal to the circumferential distance between the inner edges of the pole pieces of the field magnets, and the sets of inductors are equally spaced around the circumference of the spider, the gap between adjacent inductors being approximately equal in most cases to the circumferential length of the armature and field-magnet pole faces, and when the centre of an inductor in one set is

under the centre of the armature pole face, the centre of the gap between the two nearest inductors in the other set is also under the centre of the armature pole face.

It is clear that the details of the invention may be greatly varied without departing from it, its essential element being the employment of an inductor-rotor carrying two sets of inductors upon its circumference and at opposite sides, and of stationary armature and field magnets; so that the rotatory member not carrying field magnets and owing to the absence of windings upon it, is more easily balanced and the necessity of collector rings or the like obviated; while the form, construction, and relative positions of armature, field-magnets, and their pole pieces and of inductors may be widely varied; for instance, in some cases, the inductors may be arranged around only part of the circumference of the rotor, non-magnetic balance weights being substituted for one or more of the inductors, or each set may be arranged upon a separate spider.

In order that our invention and the manner of performing the same may be properly understood, we hereunto append two sheets of explanatory drawings, throughout which the same reference letters indicate like parts and in which Figures, 1, and 2, Sheet, 1, are, respectively, a sectional side elevation and an end elevation of one example of a generator made according to our invention, Figures, 3, and 4, on that sheet being views of details of that example, while Figures, 5, and 6, Sheet, 2, are, respectively, a sectional side elevation and an end elevation of a second example of a generator made according to our invention.

In the example of a generator shown in Figures, 1 and 2, the armature, A, built of laminations provided with a recess to take the windings, B, in the manner hereinbefore described, the windings being arranged upon the usual spool, C, of insulating material made in parts and fitted into the recess in the laminations, is carried in a casting, D, of non-magnetic material to which are also bolted, each at 60 degrees thereto, the pole pieces, E, F, of the field magnets, G. These pole pieces, E, F, are built up, as hereinbefore described, of laminations which are of the form shown separately and in plan in Figure, 3. The field magnets, G, which are of horse-shoe permanent type are secured to the pole pieces, E, F, and encircle them and the armature.

The rotor consists of a spider or drum, H, of non-magnetic material carrying upon it sets of inductors, J, K, there being in this example three inductors, J, or K, in each set. These inductors, J, K, are arc-shaped, are built up of laminations of the form shown separately in Figure, 4, and are bolted to the spider, H. The inductors, J, on the one side of the spider alternate in position with those, K, on the other side, that is to say, the centre of one inductor, J, is opposite the centre of the gap between adjoining inductors, K, and *vice versa* and their outer surfaces are cylindrical.

The rotor is arranged in close proximity to the armature, A, and pole pieces, E, F, the faces of which adjacent to it are shaped cylindrically to suit and only mechanical clearance is left between these faces and the outer circumference of the inductors, J, K, upon the rotor.

The faces of the field magnet poles, E, F, and of the armature, A, subtend an arc which may conveniently be approximately equal to two-thirds of the distance between their adjacent edges while the inductors, J, K, subtend an arc equal to the circumferential distance between the adjacent edges of the field magnet poles, E, F, and are otherwise dimensioned commensurately with the magnetic flux for which the machine is designed.

With this arrangement of inductors, J, K, it follows that if, as shown in Figure, 2, of the drawings, an inductor, J, of one set is in the position best for conveying the magnetic flux from the field-magnet pole piece, E, to the armature, A, an inductor, K, in the other set will also be in the best position for conveying the magnetic flux to the other field-magnet pole-piece, F, from the armature. A rotation of the motor an extent equal to the angle between

the field magnet poles and the armature will obviously give the position of maximum magnetic flow in the opposite direction. It is therefore evident that as the rotor rotates the magnetic flux will be alternately in opposite directions and that the machine will have a number of alternations per revolution equal to the numbers of inductors, J, and K, in each set; that is to say that with the present example there are three complete alternations in the current generated in the armature coil, B, for each complete revolution of the rotor, and six periods of maximum tension. Such an arrangement is particularly applicable in the case of internal combustion motors, as, with this number of alternations, the machine is capable of supplying current for the ignition of charges in motors having one, two, three, four, six, nine, or twelve cylinders.

An example of a similar but in a measure slightly less efficient machine having two inductors in each set and applicable to a one, two, four, or eight cylinder motor is shown in Figures, 5, and 6, Sheet, 2, of the drawings. In this example, the armature, A, is built up of laminations of rectangular horse-shoe form, the laminations in its poles being parallel with the laminations of the inductors on the rotor, while the windings, B, are arranged upon a spool, C, in the recessed part of the horse-shoe. This form of armature enables a broad pole face to be obtained without an undue increase in the sectional area of that part upon which the windings are arranged, and it may be arranged in any convenient way, that is divided into parts in any suitable manner so as to enable the spool carrying the windings, B, to be placed upon it. It is, however, obvious that a similar construction of armature to that described in the first example may be used, and that the form now described may be applied to that first example.

The pole pieces, E, F, are similar in construction to those of the foregoing example, are arranged on either side of the armature, A, and equidistant from it, and the centre of each is rather less than 90 degrees radially from the centre of the armature. The field magnets, G, which, as before, are of the horse-shoe permanent type are arranged up the opposite side of the rotor to the armature and are carried by and embrace the pole pieces, E, F.

The rotor consists of a spider, H, of non-magnetic material to which are bolted inductors built up in laminations and of a similar shape to those hereinbefore described; and similarly those, J, in the one set alternate in position with those, K, in the other set, and are of a circumferential length equal to the circumferential distances between the adjacent edges of the faces of the field magnet pole pieces, E, F. There are, however, only two inductors in each set and instead of the gaps between the adjacent inductors being approximately equal to the circumferential length of the field magnet pole faces, E, F, they are about one and a half times that length, while the armature pole face is made approximately equal in length to the gaps.

It will be seen that with these proportions, that when as shown in Figure, 6, an inductor, J, is directly below the armature, A, the opposite inductor, J, in that set is clear of the field magnet pole pieces, E, F, by an amount sufficient to prevent any excessive leakage through the lower inductor, J.

The operation of the machine is similar to that hereinbefore described, the only difference being that, instead of three, two alternations are given per revolution.

In either example the field-magnet pole-pieces, E, F, may be constructed in the manner of the armature in the example last described, and in this example if a non-magnetic balance weight is substituted for one of the inductors in each set an efficient machine for use with a single cylinder motor is produced.

It is obvious that the relative positions of armature, field magnet, their poles and the inductors, and the number of the last may be widely varied to attain particular results without departing from the spirit of the invention. For example, the inductors may be set side-by-side instead of alternating and the

field magnet poles and armature be so set relatively thereto as to achieve the desired result.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— A magneto-electric generator having a stationary armature and field and an inductor-rotor carrying two sets of inductors in series in the same magnetic field, as described.

—2— A magneto-electric generator having a stationary armature, field magnets arranged equidistantly at either side thereof and an inductor-rotor carrying two sets of circumferential inductors parallel, alternating with one another and in series in the same magnetic field, as described.

—3— In a magneto-electric generator; an inductor-rotor carrying two or more inductors in sets parallel with one another and in series in the same magnetic field, as described.

Dated this Twentieth day of February, 1905.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[G. 9366—50—7/1906.]

A.D. 1904. MAY 25. N.º 11,880.

THE ALBION MOTOR CAR CO. [LTD.] & *another's* COMPLETE SPECIFICATION.

(2 SHEETS)

SHEET 1.

(2nd Edition)

FIG. 1.

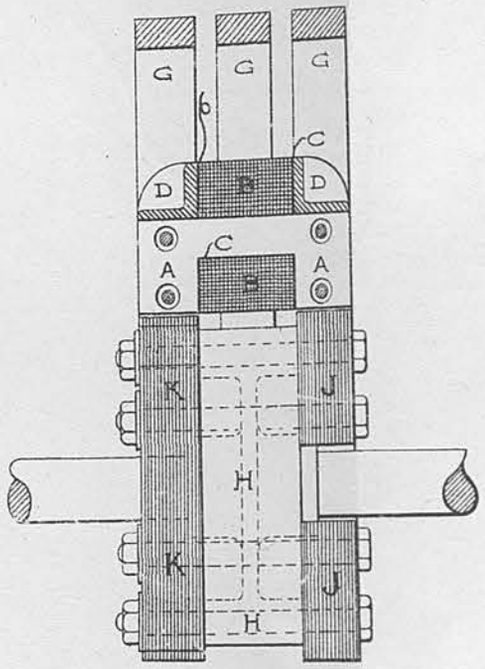


FIG. 2.

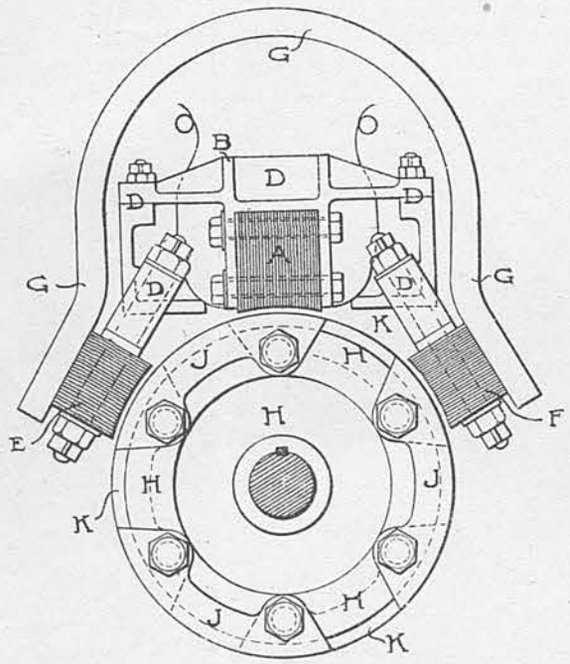


FIG. 3.

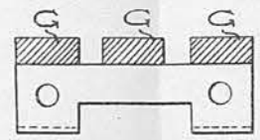


FIG. 4.

SHEET 2.

FIG. 5.

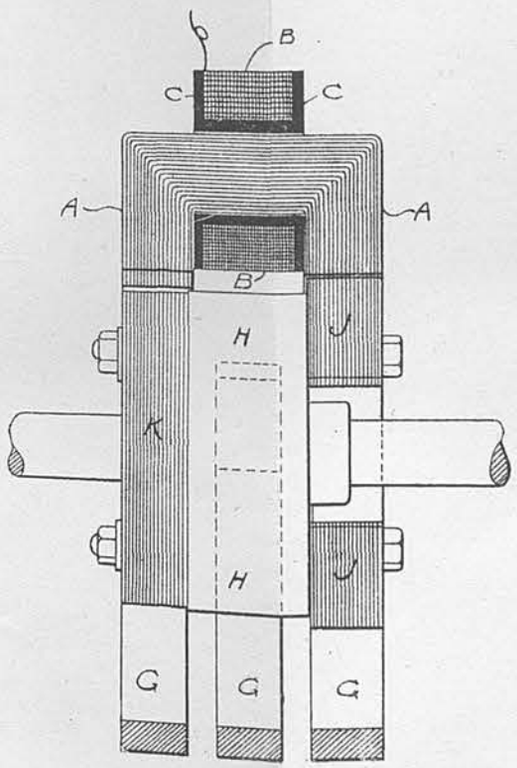
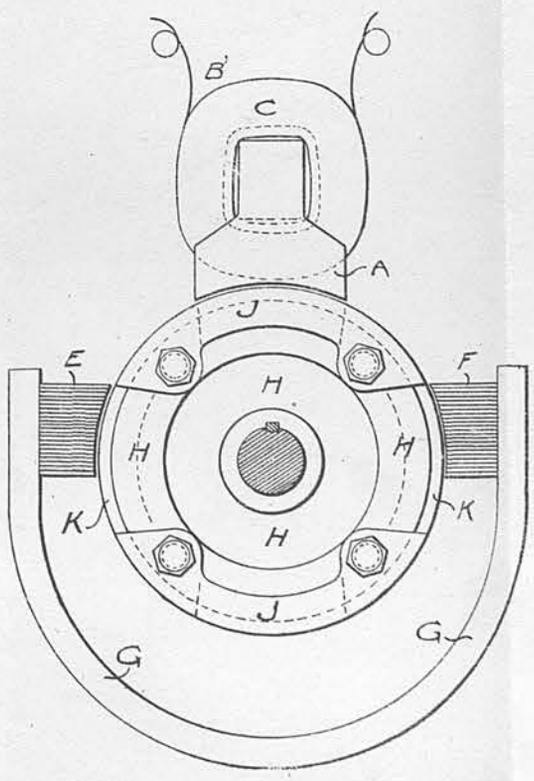


FIG. 6.



[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

[Second Edition.]

N° 14,737 A.D. 1906

Date of Application, 28th June, 1906

Complete Specification Left, 20th Dec., 1906—Accepted, 20th June, 1907

PROVISIONAL SPECIFICATION.

Improvements in Magneto-electric Generators.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to magneto-electric generators more particularly adapted for use in connection with internal combustion motors and in so far as that both armature and field are stationary and there are no windings upon the rotor (the use of collector rings being thus obviated and the rotor lending itself to more easy balancing) of the type described in our Patent Specification No. 11,880 of 1904. A generator made according to the present invention differs, however, from those described in that specification in that the axes of the poles of its field magnets are at right angles to each other—that is to say, the axis or axes of the field magnet poles is parallel with the axis of rotation of the rotor, that or those of the armature at right angles thereto—instead of all being parallel with each other as in the earlier machine.

As in the earlier machine, however, a rotor carrying two inductors conveying the magnetic flux from the field-magnets through the armature alternately in opposite directions and thereby generating an alternating current in the armature winding is employed.

The rotor consists of a pair of inductor discs or rings non-magnetically carried between the opposite pole-faces of the field magnets, the poles of which are parallel with the axis of rotation of the rotor. The discs carry horns parallel with the axis of rotation and outwardly cylindrical—that is to say, the horns are segments of cylinders. These discs or rings and their horns are so disposed as to be separated from each other sufficiently to prevent excessive magnetic leakage between them. So set relatively to the inductor rotor that its horns but not its rings or disc parts pass close to its poles—curved to the radius with clearance of the cylindrical horns—is the armature.

The field may either be energised by permanent magnets, or electro magnets may be used, and has two pole pieces of soft iron or steel adapted to so receive the inductor rotor rings or discs that the north magnetic lines are always being transmitted to the one disc or ring and the south to the other. The armature core is preferably of single horse-shoe type—but may be of the double magnetic circuit ("Manchester") type and is built up of soft iron plates shaped so as to form pole pieces embracing as already explained the rotor.

According to a simple example giving one complete alternation for each rotation of the inductor rotor, a spider of non-magnetic material carrying at each end one of the inductor-rings referred to is provided. Each inductor ring carries diametrically opposite to that on the other ring a laterally-inwards projecting segmental cylindrical horn. The pole pieces of the field magnets are bored to fit with usual clearance about the rings and the armature is fitted between the field magnets and with its pole faces fitting with usual clearance

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the segmental horns and diametrically opposite each other. The rotor is carried upon a shaft carried in bearings which may conveniently be bolted to the generator frame.

In operation, magnetic flux is constantly transmitted from one pole of the field to the one ring and horn, and from the other to the other ring and horn. As during rotation of the rotor each horn passes alternately and simultaneously over the diametrically opposed pole faces of the armature, the latter receive alternate north and south magnetic fluxes from the corresponding horns, and thus an alternating current is set up in the armature winding, there being one complete alternation for each revolution.

Dated this Twenty seventh day of June, 1906.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Magneto-electric Generators.

We, Albion Motor Car Company, Limited, of South Street, Scotstoun, in the County of Renfrew, North Britain, and Thomas Blackwood Murray, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to magneto-electric generators, more particularly adapted for use in connection with internal combustion motors, and in so far as that both armature and field are stationary and there are no windings upon the rotor, (the use of collector rings being thus obviated and the rotor lending itself to more easy balancing), of the type described in our Patent Specification No. 11,880 of 1904. A generator made according to the present invention differs, however, from those described in that specification in that the axes of the poles of its field magnets and of its armature are at right angles to each other—that is to say, the axis (or axes) of the field magnet poles is or are parallel with the axis of rotation of the rotor, that (or those) of the armature at right angles thereto—and in this is similar to certain known forms of machine.

As in the earlier machine, however, a rotor, carrying two inductors conveying the magnetic flux from the field-magnets through the armature alternately in opposite directions and thereby generating an alternating current in the armature winding, is employed.

The rotor consists of a pair of inductor discs or rings non-magnetically carried between the opposite pole-faces of the field magnets in known manner, the poles of which magnets are parallel with the axis of rotation of the rotor. The discs carry horns parallel with the axis of rotation and outwardly cylindrical—that is to say, the horns are segments of cylinders. These discs or rings and their horns are so disposed as to be separated from each other sufficiently to prevent excessive magnetic leakage between them. So set relatively to the inductor rotor that its horns, but not its rings or disc parts, pass close to its poles—curved to the radius, with clearance, of the cylindrical horns—is the armature. Such a construction is broadly known, but according to the present invention, and in order to attain in an inductor rotor of reasonable size sufficient air space between and at the same time sufficient mass in the horns to carry a sufficient flux, only two horns set at 180 degrees to each other are used, (of course, certain opposite pairs of horns in the known multiple horn types of machine have been at 180 degrees to each other).

The field may either be energised by permanent magnets, or electro magnets may be used, and it has two pole pieces of soft iron or steel adapted to so receive the inductor rotor rings or discs that the north magnetic lines are always being transmitted to the one disc or ring and the south to the other. The armature core is preferably of single horse-shoe type—but may be of the double magnetic circuit ("Manchester") type and is built up of soft iron plates shaped so as to form pole pieces embracing as already explained the rotor. It has its pole faces at 180 degrees to each other and in the horizontal axial plane of the shaft.

In order that the invention and the manner of performing the same may be properly understood, there is hereunto appended a sheet of explanatory drawings showing in transverse sectional elevation in Figure 1, and in longitudinal sectional elevation in Figure 2, the improved generator.

This generator gives one complete alternation for each revolution of the inductor-rotor, and according to it there is provided on a spindle, A, a spider or carrying sleeve, B, of non-magnetic material carrying at opposite ends inductor rings, C, D. Each inductor ring, C, D, has formed upon it a laterally-inwards projecting horn, E, F, the horn, E, upon one inductor ring, C, being diametrically opposite the horn, F, upon the other inductor ring, D, as will clearly be seen in Figure 1.

The pole pieces, G, H, of the field magnets, J,—of usual permanent type are secured to the magnets by studs, K, and are bored to fit with usual clearance about the inductor rings, C, D.

The pole pieces of the armature consist of a series of laminated plates, L, of horse shoe form embracing with usual clearance the horns, E, F, of the inductor rings, C, D, and carrying a winding, M, and having pole faces, N, O.

The rotor-carrying spindle, A, is carried in bearings, P, which may conveniently be secured to the main frame, R, carrying armature and field magnets.

In operation, magnetic flux is constantly transmitted from one pole, G, of the field to the one ring, C, and horn, E, and from the other pole, H, to the other ring, D, and horn, F. As during rotation of the rotor each horn, E, F, passes alternately and simultaneously over the diametrically opposed pole faces, N, O, of the armature, the latter receive alternate north and south magnetic fluxes from the corresponding horns, E, F, and thus an alternating current is set up in the armature winding, M, there being one complete alternation for each revolution.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

In a magneto electric generator, an inductor-rotor consisting of a non-magnetic carrier carrying horned ring inductors, each with a single horn, the ring parts of which are embraced by the pole pieces of field magnets, the axes of the poles of which are parallel with the axis of rotation of the rotor and the single horns of which set at an angle of 180 degrees to each other convey alternate magnetic flux to the poles of an armature whose axes are at right angles or substantially at right angles to those of rotor and field magnets, and in the horizontal plane of the axis of rotation of the rotor, as described.

Dated this Nineteenth day of December, 1906.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 15—25/4/1913].

[This Drawing is a reproduction of the Original on a reduced scale.]

(2nd Edition)

FIG.1.

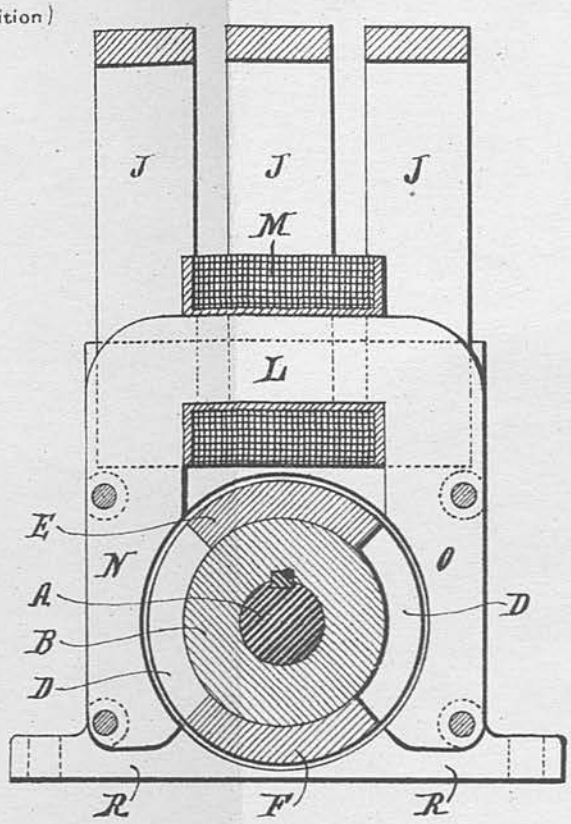
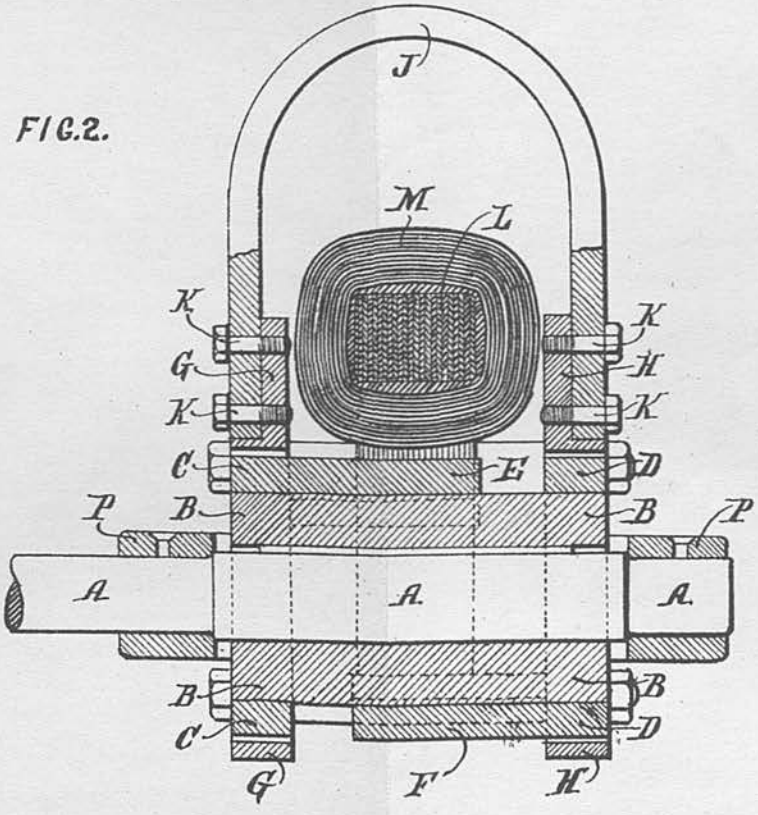


FIG.2.



Malby & Sons, Photo-Litho.

[Second Edition.]

7.

N° 27,570 A.D. 1906

Date of Application, 4th Dec., 1906
Complete Specification Left, 22nd May, 1907—Accepted, 31st Oct., 1907

PROVISIONAL SPECIFICATION.

"Improvements in Magnetc-electric Generators for Ignition in Internal Combustion Motors".

We, Albion Motor Car Company, Limited, of South Street, Scotstoun, in the County of Renfrew, North Britain, and Thomas Blackwood Murray, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention to be as follows:—

In internal combustion motors, as is well known, it is necessary to advance the point where ignition takes place when and as the speed of the motor increases. It is therefore desirable that the best sparking position of the magneto armature should move angularly backwards relatively to the direction of its rotation as its speed increases. Unfortunately, for their effectiveness, in magneto electric generators of usual form in which the armature is of Siemen's "H" or like type exactly the reverse takes place—the "best sparking" point travels in the direction of rotation as the speed increases. Hence, if the armature be set most suitably, relatively to the motor crank shaft, for high speeds, it is not in its most effective position for low speeds, and *vice versa*. A usual means of overcoming this disability has been to fix the armature relatively at an intermediate position and make the generator sufficiently powerful to give a moderately effective spark even under its two worst conditions—excessively high and excessively low speed. Mechanical devices for altering the relative position of the armature while running and under control of a governor or of the driver have also been used.

This invention has for its object, however, to so construct the armature of the generator that the "best sparking" point retrogrades, as the speed increases and it consists essentially in gradually reducing the effective area of the trailing edge or face of the armature pole.

This may be accomplished by bevilling of the trailing armature pole tips in one direction or in both directions meeting at the centre and at an angle to the armature axis. It is found that an axial angle of 23 degrees is effective.

The leading edges of the armature poles are as heretofore in axial plane.

Or, conversely, the field pole trailing tips may be bevilled instead of the armature, or both may be bevilled and the angle divided between them.

It is clear that the construction is applicable to practically all the well known forms of polar armatures, such as Siemen's H armature and modifications thereof and multipolar armatures such as Louten's and modifications thereof, laminated or otherwise, and to machines having either permanent or electro magnetic field magnets. Tests with armatures constructed in this manner have shown that at low speeds the best spark is obtained after the farthest corner of the trailing edge of the armature pole has quite cleared the field pole piece. As the speed increases the best position for sparking gradually recedes from this position, and further that at high speeds a good spark is got even although a portion of the trailing pole piece is still under the trailing edge of the field pole piece it is leaving.

The generator therefore has a characteristic approximating closely to the desired conditions, or has what we might call a reverse characteristic, and it

[Price 8d.]

PRICE 6d.

would appear that the magnetic lines at low speeds resist cutting till the last moment and crowd into the triangular corner of the trailing armature pole piece, thus retarding the maximum spark effect until a clear gap has been formed, whereas as the speed rises a sufficient number of these lines are apparently cut as soon as the spiral trailing edge of the pole piece begins to leave the field magnet pole piece, with the result that there is a sufficient change of induction through the armature winding to give a satisfactory spark. The apparent reluctance of the lines to crowd themselves into the trailing pole tip at higher speeds is probably due to the fact that the field magnet pole pieces are solid and a rapid redistribution of the lines in the face would induce considerable Foucault currents and a balance between these effects takes place, depending upon the speed of the magneto.

Dated this Third day of December, 1906.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

"Improvements in Magneto-electric Generators for Ignition in Internal Combustion Motors".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

In internal combustion motors, as is well known, it is necessary to advance the point where ignition takes place when and as the speed of the motor increases. It is therefore desirable that the best sparking position of the magneto armature should move angularly backwards relatively to the direction of its rotation as its speed increases. Unfortunately, for their effectiveness, in magneto electric generators of usual form in which the armature is of Siemens "H" or like type exactly the reverse takes place—the "best sparking" point travels in the direction of rotation as the speed increases. Hence, if the armature be set most suitably, relatively to the motor crank shaft, for high speeds, it is not in its most effective position for low speeds, and *vice versa*. A usual means of overcoming this disability has been to fix the armature relatively at an intermediate position and make the generator sufficiently powerful to give a moderately effective spark even under its two worst conditions—excessively high and excessively low speed. Mechanical devices for altering the relative position of the armature while running and under control of a governor or of the driver have also been used.

This invention has for its object, however, to so construct the armature of the generator that the "best sparking" point retrogrades, as the speed increases, and it consists essentially in gradually reducing the effective area of the trailing edge or face of the armature pole.

This may be accomplished by bevilling the trailing armature pole tips

in one direction or in both directions meeting at the centre and at an angle to the armature axis. It is found that an axial angle of 23 degrees is effective.

The leading edges of the armature poles are as heretofore in axial plane.

Or, conversely, the field pole trailing tips may be bevilled instead of the armature, or both may be bevilled and the angle divided between them.

Of course it is well known to bevil both edges of armature poles, but it is here pointed out that according to the present invention only the trailing edges are bevilled, and for a purpose entirely different from that for which beviling of both faces has been adopted.

It is clear that the construction is applicable to practically all the well known forms of polar armatures, such as Siemens "H" armature and modifications thereof and multipolar armatures such as Lontin's and modifications thereof, laminated or otherwise, and to machines having either permanent or electro magnetic field magnets. Tests with armatures constructed in this manner have shown that at low speeds the best spark is obtained after the farthest corner of the trailing edge of the armature pole has quite cleared the field pole piece. As the speed increases the best position for sparking gradually recedes from this position, and further that at high speeds a good spark is got even although a portion of the trailing pole piece is still under the trailing edge of the field pole piece it is leaving.

The generator therefore has a characteristic approximating closely to the desired conditions, or has what we might call a reverse characteristic, and it would appear that the magnetic lines at low speeds resist cutting till the last moment and crowd into the triangular corner of the trailing armature pole piece, thus retarding the maximum spark effect until a clear gap has been formed, whereas as the speed rises a sufficient number of these lines are apparently cut as soon as the spiral trailing edge of the pole piece begins to leave the field magnet pole piece, with the result that there is a sufficient change of induction through the armature winding to give a satisfactory spark. The apparent reluctance of the lines to crowd themselves into the trailing pole tip at higher speeds is probably due to the fact that the field magnet pole pieces are solid and a rapid redistribution of the lines in the face would induce considerable Foucault currents and a balance between these effects takes place, depending upon the speed of the magneto.

In order that the invention and the manner of performing the same may be properly understood, there are hereunto appended two sheets of explanatory drawings showing the application of the improvements to various types of magneto-electric generators hereinafter specified.

In Figure 1, Sheet 1, in sectional plan is shown a generator of the type described in Clark's Specification No. 5958 of 1887 and having the trailing tips, A, of its armature poles, B, bevilled in one direction to the axis of the armature—as already explained, the bevilling might be in both directions meeting in a central tip.

Figures 2 and 3, Sheet 2, show in elevation and in plan respectively an ordinary Siemens "H" armature, the trailing tips, A, of the poles, B, of which are bevilled in similar manner—they also might be double-bevilled meeting centrally.

In Figures 4 and 5, in elevation and plan respectively and in like positions in Figures 6 and 7, are shown generators of the type described in the prior Patent Specification No. 14,732 of 1902. In the first, the trailing tips, A, of the armature poles, B, are bevilled as described. In the second the trailing tips, C, of the field poles, D, are bevilled—an alternative method already described as having the same effect.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

In magneto-electric generators, armature or field trailing pole tips bevilled

in one or both directions substantially as, and for the purposes, hereinbefore described.

Dated this Twenty first day of May, 1907.

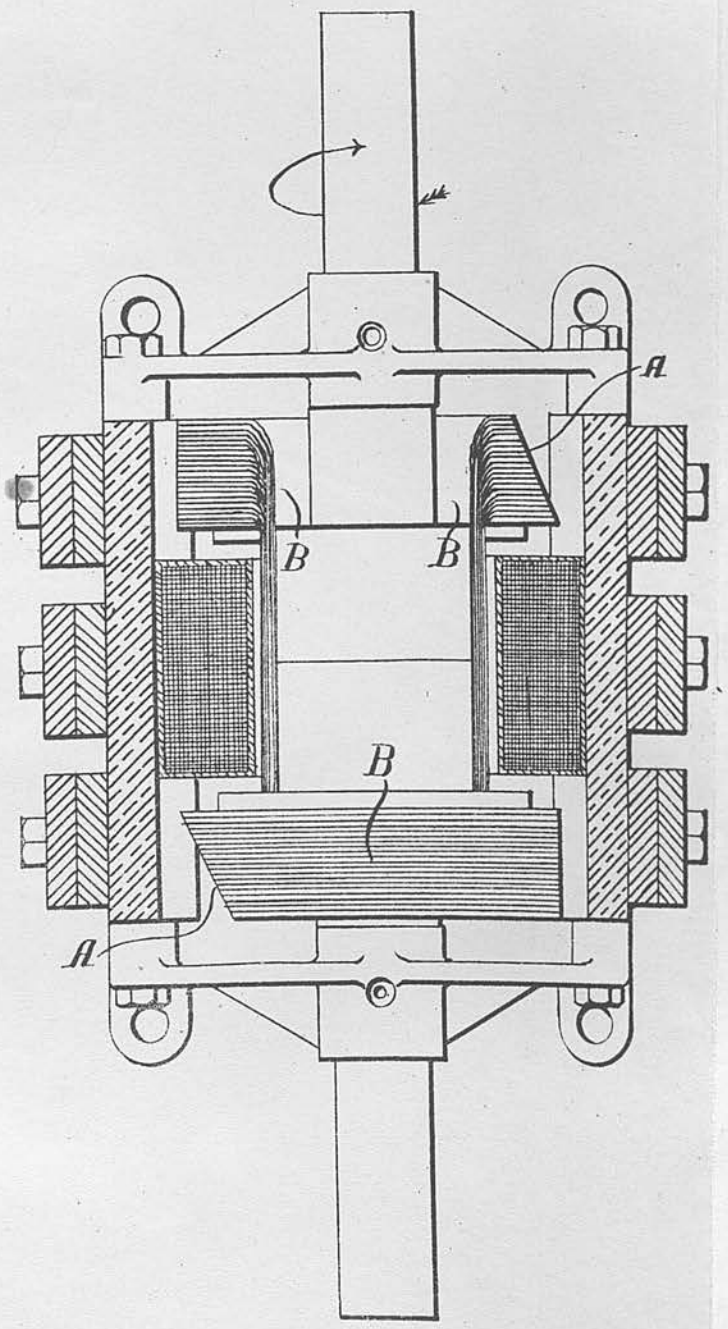
EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 42—50/3/1912.]

SHEET 1.

(2nd Edition)

FIG. 1.



SHEET 2.

FIG. 2

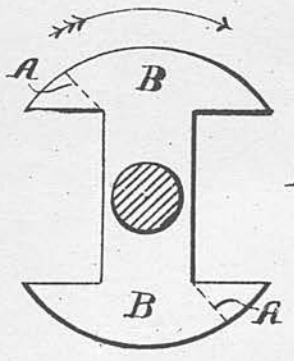


FIG. 4

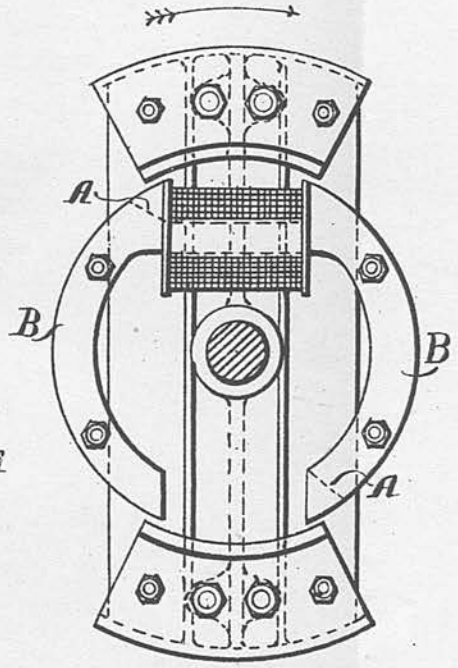


FIG. 6.

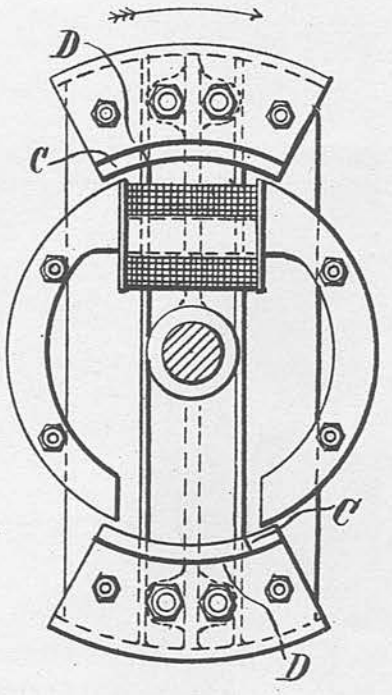


FIG. 3

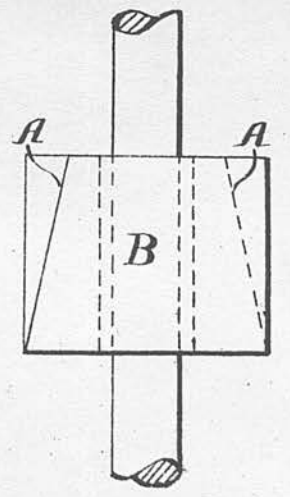


FIG. 5

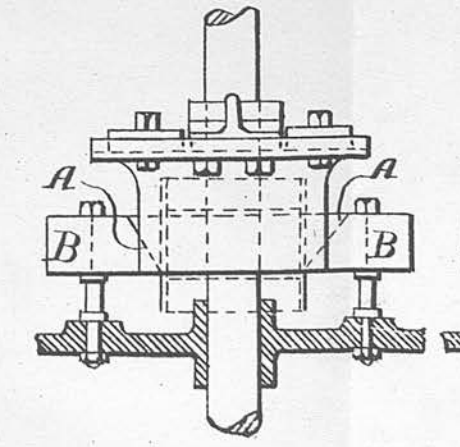
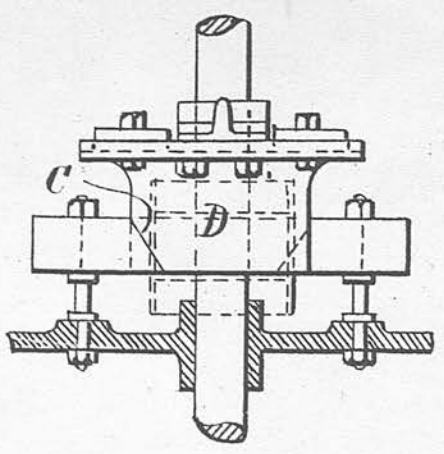


FIG. 7.



Malby & Sons, Photo-Litho.

8.

N° 5155 A.D. 1907

Date of Application, 4th Mar., 1907

Complete Specification Left, 20th Aug., 1907—Accepted, 19th Dec., 1907

PROVISIONAL SPECIFICATION.

"Improvements in Magneto-electric Generators".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention has for its object to provide a magneto-electric generator for use for ignition in multi-cylinder internal combustion motors—especially such as have three or six cylinders—and in which the rotor moves at engine or lower speed.

The improved generator is of modified "Paccinotti ring" type having a stationary armature and windings and a rotatory field.

The field is bi-polar and consists of diametrically opposed pole pieces magnetised either by straight bar permanent magnets as in the machine described in Murray and Fulton's prior Specification No. 14,732 of 1902, or the magnets may be semicircular and embrace the armature. Or instead of permanent magnets electro-magnets may be used.

The armature is built up of sector-shaped laminations mounted upon a stationary non-magnetic spider. These core pieces are recessed and carry windings in usual manner.

There are six windings which however are not connected consecutively but each to that diametrically opposed to it.

It is to be understood that there is no substantial novelty in these parts. The essence of the invention, however, lies in the provision of comparatively narrow radial air gaps in the armature ring. These gaps are arranged either between each winding or between each pair of windings, and are therefore at either 60 or 120 degrees to each other.

It is usual with generators of this type to short circuit the armature coils and when the current generated in them is at about its maximum to rupture their circuits thus taking advantage of the current self induced in the circuits owing to the rapid collapse of the lines of magnetic force. For this reason it is desirable that the collapse of the lines of magnetic force should be as rapid as possible. The air gaps forming the subject-matter of the present invention materially hasten the collapse, thus materially increasing the efficiency of the generator, while if the gaps be not of undue width the magnetic reluctance of the armature as a whole is not seriously increased.

Dated this Second day of March, 1907.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow.
Applicants Agents.

~~[Price 8d.]~~
PRICE 6d.

COMPLETE SPECIFICATION.

"Improvements in Magneto-electric Generators".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention has for its object to provide a magneto-electric generator for use for ignition in multi-cylinder internal combustion motors—especially such as have three or six cylinders—and in which the rotor moves at engine or lower speed.

The improved generator is of modified "Paccinotti ring" type having a stationary armature and windings and a rotatory field.

The field is bi-polar and consists of diametrically opposed pole pieces magnetised either by straight bar permanent magnets as in the machine described in Murray and Fulton's prior Specification No. 14,732 of 1902, or the magnets may be semi-circular and embrace the armature. Or instead of permanent magnets electro-magnets may be used.

The armature is built up of sector-shaped laminations mounted upon a stationary non-magnetic spider. These core pieces are recessed and carry windings in usual manner.

There are six windings which, however, are not connected consecutively but each to that diametrically opposed to it.

It is to be understood that there is no substantial novelty in these parts. The essence of the invention, however, lies in the provision of comparatively narrow radial air gaps in the armature ring. These gaps are arranged either between each winding or between each pair of windings, and are therefore at either 60 or 120 degrees to each other.

It is usual with generators of this type to short circuit the armature coils and when the current generated in them is at about its maximum to rupture their circuits thus taking advantage of the current self induced in the circuits owing to the rapid collapse of the lines of magnetic force. For this reason it is desirable that the collapse of the lines of magnetic force should be as rapid as possible. The air gaps forming the subject-matter of the present invention materially hasten the collapse, thus materially increasing the efficiency of the generator, while if the gaps be not of undue width the magnetic reluctance of the armature as a whole is not seriously increased.

In order that the invention may be readily understood a sheet of drawings is hereunto appended. This shows in Figure 1, an example of a generator of the modified Paccinotti ring type hereinbefore referred to in vertical section, and, in Figure 2, an elevation of the armature thereof showing the air gaps which are the subject of the present invention.

In this example, which is suitable for a six cylinder motor when driven at engine speed, the rotatory field is formed of semicircular permanent magnets, A, carried by a spider, B, fixed to the shaft, C, while the armature is built up of sector shaped laminations, D, mounted upon a fixed non-magnetic spider, E. These laminated core pieces, D, are recessed and carry windings, G, in usual manner. The windings, G, of which there are six are connected each

one to that one diametrically opposed to it. The windings may either be connected in parallel or in series. In either case of course, they must be so connected as not to neutralise each other, but so that the sum of electric current generated may be obtained, either in electro motive force, or in increased current according as they are either connected in series or in parallel.

The core pieces, D, are of such size and so disposed that there are left between them air gaps, H, the subject of the invention, these being between each winding so that in this instance the gaps, H, are at 60 degrees to each other.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

In magneto-electric generators of the type referred to, air gaps between adjacent armature poles or between adjacent pairs of poles, as described.

Dated this Nineteenth day of August, 1907.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow.
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1908.

FIG. 1.

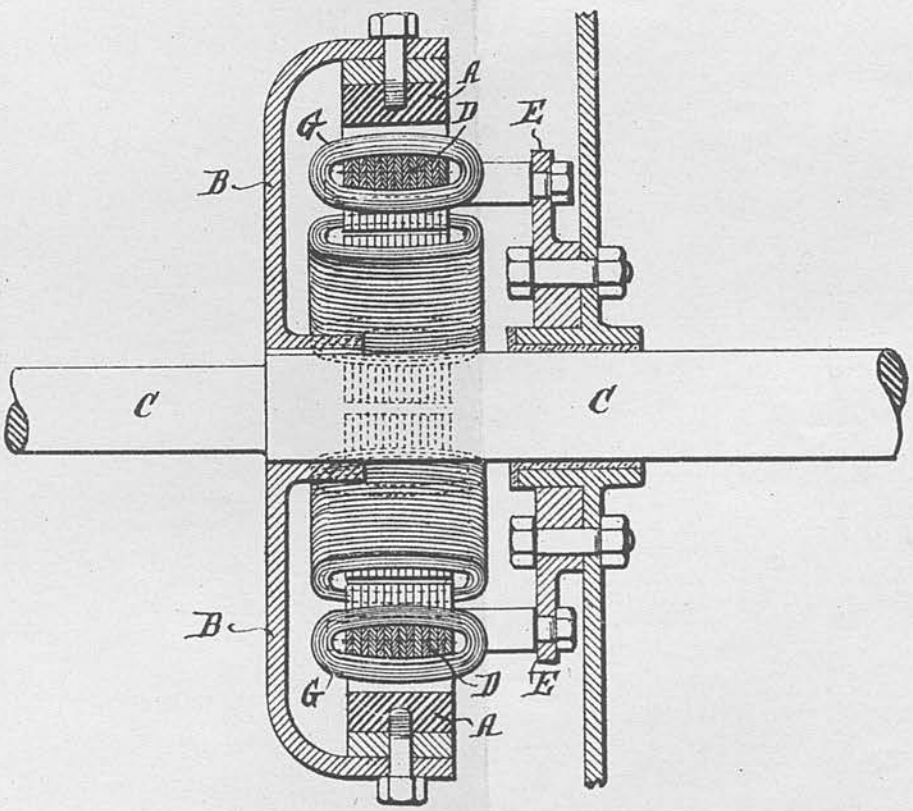
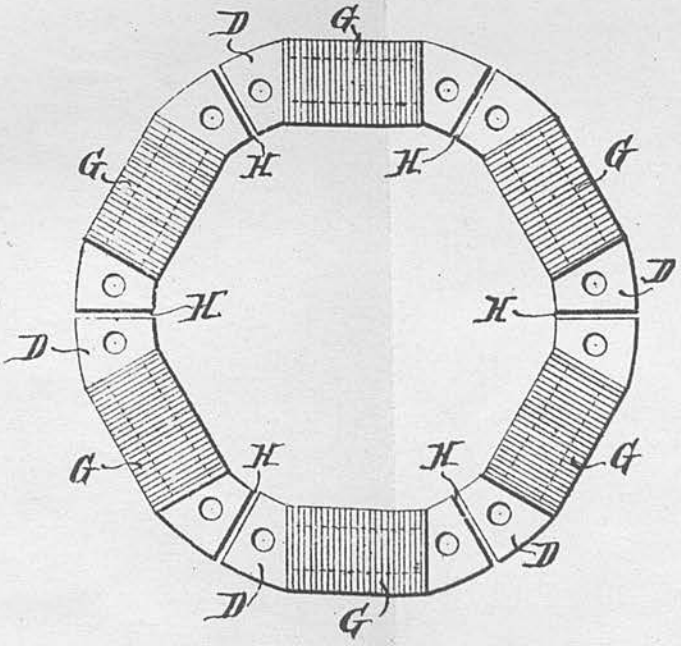


FIG. 2.



Malby&Sons, Photo-Litho.

[Second Edition.]

9.

N° 13,034 A.D. 1904

Date of Application, 9th June, 1904—Accepted, 14th July, 1904

COMPLETE SPECIFICATION.

"Improvements in or connected with Carburettors for Internal-combustion Motors".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, of the same place, Engineer, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to carburettors of the well-known float-feed spray type, for use in connection with volatile hydrocarbon fuel in internal combustion motors, and in which means are employed for varying the proportion of air entering the carburettor coincidently with variation in the speed of the motor. In such devices, as hitherto generally constructed, an auxiliary air inlet controlled either by devices operated by the suction of the motor piston, or by the variation in pressure in the water-cooling system of the motor has been used. The forces thus available to operate such devices are necessarily small, and consequently the devices have to be fragile, and are liable to get out of order.

This invention has for its object to control the auxiliary air inlet by a centrifugal governor of long range, a device much more certain in its action, capable of developing much greater forces for the operation of the air valve, and consequently admitting of the use of less fragile and less easily deranged apparatus than those hithereto proposed or in use.

In carrying out the invention, the auxiliary air valve of the carburettor, which may be of any convenient form, is directly connected to a centrifugal governor of the type described in Murray and Fulton's Patent Specification No. 9251 of 1902, in which the usual throttle valve of the carburettor is connected through differential or "floating lever" devices with the governor. This form of governor is of extremely wide range, and it is only with a governor of such wide range that a satisfactory result can be obtained with a governor-operated auxiliary air valve; as, for instance in the case of a motor running at a maximum speed of 1,000, revolutions per minute, the governor should commence to open the auxiliary air valve at about 200 revolutions per minute and continue to open it by approximately equal amounts with equal increments of speed, until the maximum speed is attained—a result unattainable with any other form of governor.

In order that the invention, and the manner of performing the same may be properly understood, we hereunto append a sheet of explanatory drawings, throughout which, like reference letters indicate like parts, and in which Figure 1, is an elevation to some extent diagrammatic of the complete apparatus, while Figures, 2, and 3, are respectively a side elevation and a vertical section of the improved carburettor.

In carrying out the invention, according to the example shown in the drawings, the carburettor is of the spray type having a *vena contracta*, A, (Figure, 3,) through which the air to form the explosive mixture is drawn by the suction of the motor piston. Placed centrally in this *vena contracta* is a fuel nozzle, B, which is supplied with fuel at a constant level by any one of the well-known forms of float-feed device. The outlet, C, from the carburettor to the motor is controlled by a cylindrical throttle valve, D, acting upon an annular seat, E,

[*Price 8d.*]

in the usual manner, and the body, F, of the carburettor is surrounded by a jacket, G, through which hot gases or water may be led to prevent freezing, and increase volatilisation of the fuel; while the whole apparatus may conveniently be bolted to the motor by the flange, H.

On the side of the carburettor body, F, a flat surface, J, (Figure, 2,) is formed. An aperture, K, is formed through the body of the carburettor in this surface at a point approximately opposite the centre of the *vena contracta*, A.

The aperture, K, is covered by a flat shutter or valve, L, pivoted upon a pin, M, and pressed against the surface, J, by a spiral spring acting between the head of the pin and the shutter or valve. The valve, L, is operatively connected to the governor, N, (Figure, 1,) by a link, O, and lever, P, carried on a fulcrum, R, the connection being so arranged that when the governor is at rest, the valve, L, entirely covers the aperture, K, and as the governor gradually increases in speed, the aperture is more and more uncovered by the valve, until, when the governor and motor have attained their maximum speed, the aperture is entirely uncovered; the valve, L, then being in a position shown in dotted lines in Figure, 2. The contour of the aperture, K, is so designed relatively to the characteristic of the governor that its area exposed by the valve, L, is such, at any given speed, as to admit the auxiliary proportion of air necessary at that speed to preserve a properly proportioned explosive mixture.

The improved device is shown in Figure 1, (to some extent diagrammatically) arranged in connection with a differential or "floating lever" and governor arrangement of the type described in the Patent Specification hereinbefore referred to.

In this arrangement, the lever, P, operatively connected to the governor, N, is connected to one end of a floating lever, S, by a link, T, the other end of the floating lever being connected to a hand lever, U. The floating lever, S, is connected at its centre to a rod, V, carrying the throttle valve, D, so that the speed at which the governor operates the throttle valve can be varied by adjustment of position of the hand lever, U, in the manner described in the Patent Specification hereinbefore referred to.

The hereinbefore described combination possesses great advantage in that, as the valve, L, controlling the auxiliary air supply is directly connected to the governor, while the throttle valve, D, is connected thereto through the floating lever device, the motor may be set to run at any desired speed, while at the same time the auxiliary air supply is always commensurate with that speed.

Instead of the form of floating lever device described and shown, gearing or other equivalent devices may be employed.

Having now particularly described and ascertained the nature of the said invention, and in what manner the same is to be performed, we declare that what we claim is:—

In connection with a carburettor; the combination of an auxiliary air inlet aperture in the carburettor, controlled by a valve operatively connected to a governor; the inlet aperture being so shaped as to admit air proportionately to the speed of the motor; with a throttle valve in the carburettor connected to the governor through a floating lever or equivalent device, one element of which is adjustable by hand, as described.

Dated this Eighth day of June, 1904.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[G. 9371—50—7/1906.]

ALBION MOTOR CAR CO. [LTD.] & *another's* COMPLETE SPECIFICATION. (1 SHEET)

(2nd Edition)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

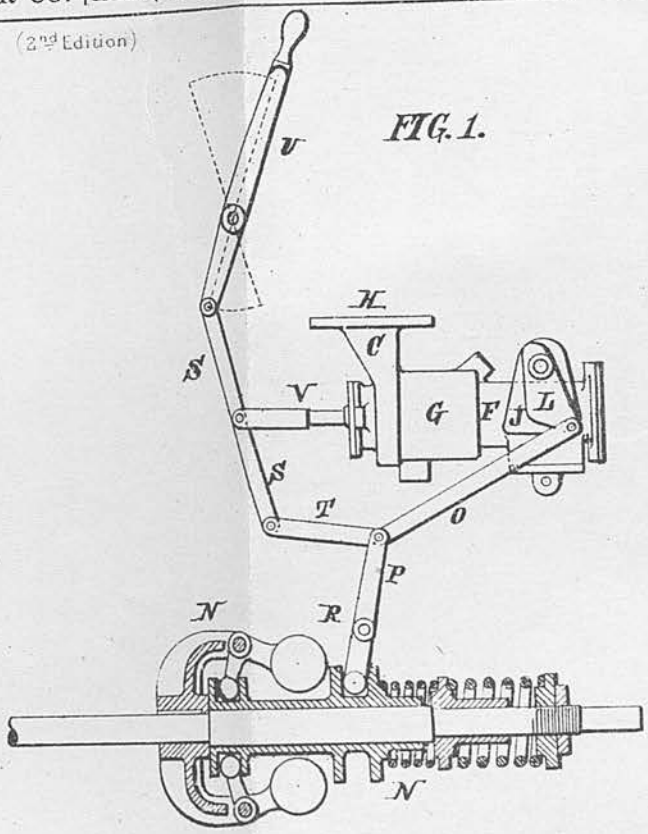


FIG. 2

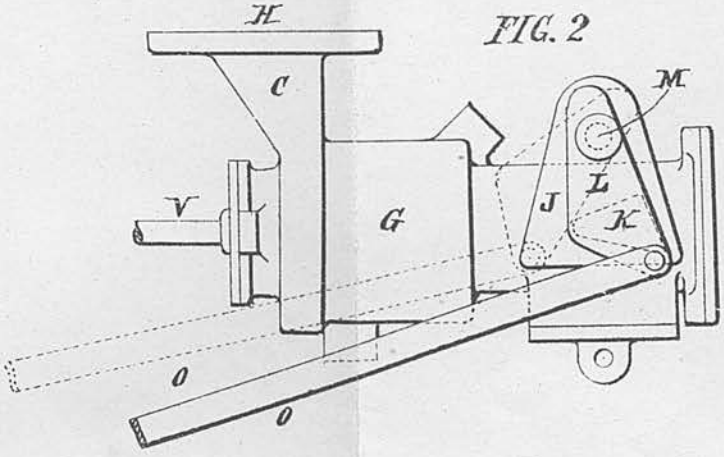
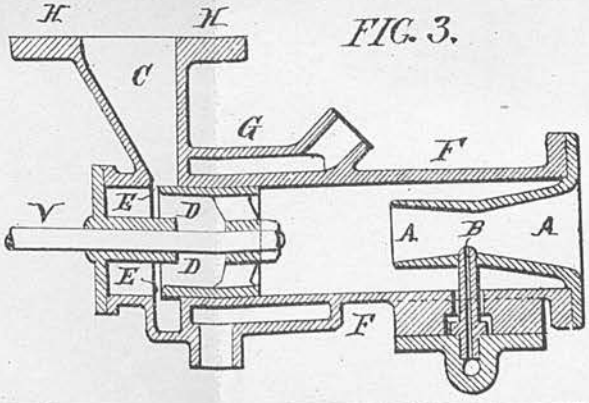


FIG. 3.



Malby & Sons, Photo-Litho.

[Second Edition.]

15.

N° 28,362 A.D. 1904

Date of Application, 27th Dec., 1904—Accepted, 2nd Feb., 1905

COMPLETE SPECIFICATION.

"Improvements in or connected with Carburettors for Internal Combustion Motors."

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention relates to carburettors for use in connection with volatile hydro-carbon fuel in internal combustion motors, and of the type in which the admission of air by an auxiliary inlet valve is controlled by a centrifugal governor or other device operating by variations of speed of the motor, that is to say, of the type described in our Patent Specification No. 13,034 of 1904 for example. Such a device acts perfectly and gives a correct mixture for all speeds of the motor when the latter is working at or near its full load, but when the load is light and the speed of the motor high the relative proportion of air becomes too high, slow combustion results, and there is danger of combustion persisting throughout the exhaust stroke and causing pre-ignition of the succeeding ingoing charge. Our present invention has for its object to overcome this defect, and we find that this object is attained by reducing the area of the device-controlled auxiliary air valve and adding a second air valve connected to and moving synchronously with the usual throttle valve.

In order that our invention and the manner of performing the same may be properly understood, we hereunto append a sheet of explanatory drawings, throughout which like reference letters indicate similar parts, and in which Figure, 1, is a sectional side elevation of part of a carburettor of the type described in our specification hereinbefore referred to, and fitted with an example of our present improvements, while Figures, 2 and 3, are, respectively, sectional side and sectional end elevations of a similar carburettor fitted with a second example, Figures, 4 and 5, being similar views of a third example.

In carrying out our invention according to the example shown in Figure, 1, of its application to a carburettor of the type described in our earlier specification hereinbefore referred to, and in which an auxiliary air inlet, K, controlled by a flat valve operated by the governor connections, is formed in the body, F, of the carburettor, we form in the body, F, a second air inlet port, A, the admission of air through which is controlled by an aperture, B, in the throttle valve, D, which is of the piston type. The port, A, and aperture, B, are in such positions that the port, A, is just closed by the piston throttle valve, D, at the instant that valve has closed the port, E, controlling the flow of mixture to the motor. The port, A, and aperture, B, are made of such a size that the port is entirely uncovered synchronously with the opening of the port, E, practically equivalent to the full area of the outlet to the motor.

It has been found that if one-third of the total extra air (that is the air admitted by the inlet, K, and by the port, A, together) required at the highest speed and maximum load is controlled synchronously and proportionately with the throttle valve the object desired will be obtained. That is to say, that the port, A, is one-half the area of the inlet aperture, K, so that it supplies one-third of the total extra air and is so controlled by the movement of the valve, D, that when the motor is running at the highest speed admitted by the governor without load and the port, E, is practically closed by the valve, D, the

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PRICE 6d.

port, A, is also practically closed and the mixture only receives two-thirds of the total possible extra air. When, however, the motor is run at full speed and full load, the throttle valve, D, is set with the port, E, so as to give full area, and, at the same time, the port, A, is uncovered to its full area giving the fullest volume of extra air.

This action takes place throughout the range of movement of the throttle valve, D, the area of the port, A, being varied proportionately and synchronously, with the variation in area of the port, E, caused by the movement of the throttle valve. This arrangement has the advantage among others that it ensures that whenever the throttle valve is suddenly opened to accelerate the motor or to meet an increased load, an increased supply of air is synchronously admitted to the mixture thus preventing the choking or drowning of the motor, ordinarily apt to result from a sudden opening of the throttle valve, which, as there is no immediate increase in speed, does not cause the governor to affect the active area of the air inlet, K.

The essence of the invention is the application of an additional air inlet valve moving synchronously with the throttle valve and it is obvious that it may be carried into effect in a variety of ways and be applied to various forms of this type of carburettor (that is:—the type of carburettor in which an auxiliary air inlet valve controlled by the speed of the motor is used) other than the specific form hereinbefore referred to.

In the further example shown in Figures, 2, and 3, of the application of our invention to that form of carburettor hereinbefore referred to, the port, A, is formed in the bottom of the body, F, of the carburettor and opens into a chamber formed therein by partitions, C. This chamber is so positioned that it is uncovered by the throttle valve, D, synchronously and to the same extent as that valve uncovers the throttle port, E, which is formed by the remainder of the circumference. The area of the port, A, may conveniently be one-half that of the port, K.

According to the example shown in Figures, 4 and 5, the throttle valve, D, is of the rotary trunnion type, and has formed in its periphery a throttle port, E, at the one side co-operating with the discharge passage to the motor, and at the other side an inlet aperture, B, co-operating with the air inlet port, A.

Instead of the additional air valve being directly connected to or formed in a piece with the throttle valve, it may be operated therefrom to the same end by rods, or links and levers, or by gearing.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1—In a carburettor having an auxiliary air inlet valve controlled by the speed of the motor, a supplementary air port the active area of which is altered synchronously with the area of a throttle port, as described.

—2—In a carburettor having an auxiliary air inlet valve controlled by the speed of the motor, a supplementary air valve operatively connected to a throttle valve and moved synchronously and proportionately therewith, as described.

—3—In a carburettor having an auxiliary air inlet valve controlled by the speed of the motor, a throttle valve controlling the supply of mixture to a motor and at the same time controlling the passage of additional air through a supplementary air port, as described.

Dated this Twenty sixth day of December, 1904.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[G, 9385—50—7/1906.]

A.D. 1904. DEC. 27. N.º 28,362.

ALBION MOTOR CAR CO. [LTD.] & *another's* COMPLETE SPECIFICATION. *(1 SHEET)*

[This Drawing is a reproduction of the Original on a reduced scale]

(2nd Edition)

FIG. 1.

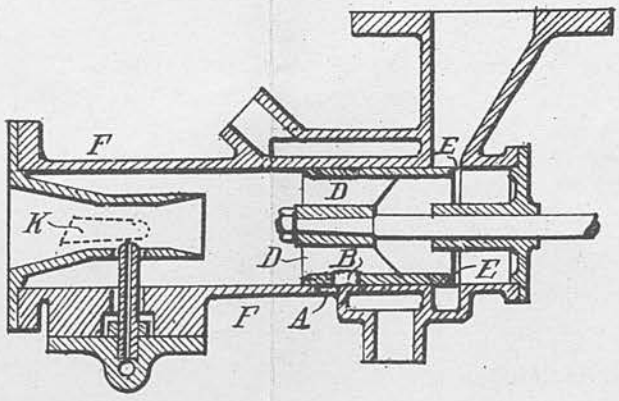


FIG. 2.

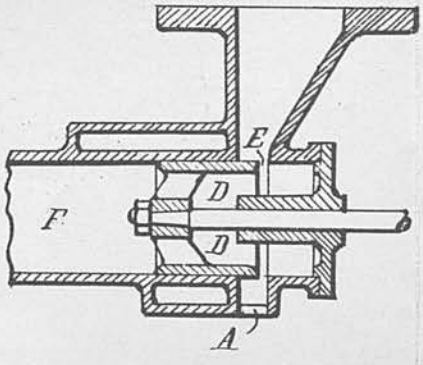


FIG. 3.

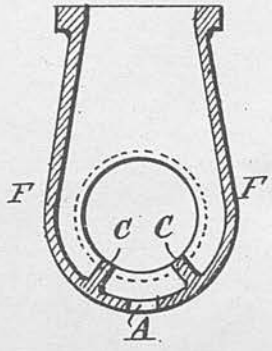


FIG. 4.

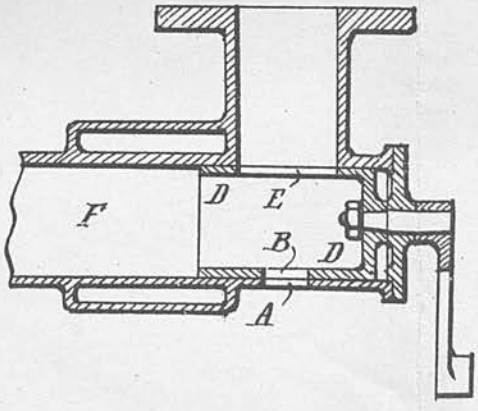
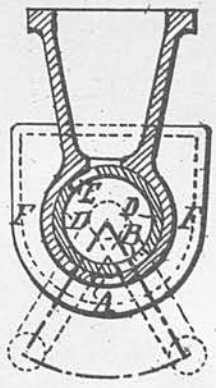


FIG. 5.



Malby&Sons, Photo-Litho.

[Second Edition.]

N° 14,198 A.D. 1908

Date of Application, 4th July, 1908

Complete Specification Left, 31st Dec., 1908—Accepted, 13th May, 1909

PROVISIONAL SPECIFICATION.

Improvements in Carburettors for Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

That type of carburettor in which a mixture too rich for combustion is diluted with air before it reaches the engine and in which throttling valves control the mixture and the air—which valves have at all positions experimentally determined proportionate openings—is very effective so long as the speed of the engine and the corresponding velocity of gas and air is great enough for there to be throttling action at the valves. But as soon as the air and gas velocities cease to be so sufficient, the action fails, because the proportion of gas falls, owing to the greater resistance offered by the jet and gas passages than is offered by the air passages.

This invention has for its object to provide means, in conjunction with such a carburettor, for overcoming this disability, and it consists essentially in providing in addition to what may be termed the static air and gas throttling device, an air throttling valve controlled by the speed of the engine and controlling the admission of air to the main air throttle valve. This speed valve may be operatively connected to any suitable form of governor, but preferably, that described in the Specification of Murray and Fulton's Patent No. 9251 of 1902 is employed. There is preferably also provided a valve which may be of hit-and-miss type for admitting air to the main throttle valve, irrespectively of the position of the speed valve, and for starting purposes, and weather and temperature adjustment of the mixture proportions.

Obviously, this novel speed-control air valve may be applied to any of those existing carburettors in which an over-rich mixture afterwards diluted with air is made—it being applied to the additional air inlet in such manner as to control the amount of air reaching the additional air valve. The invention has, however, further for its object an improved and simple carburettor embodying the improved device.

In this carburettor, air is drawn through a circumscribed orifice past a simple float-feed controlled jet nozzle, the region about which, and the passage to the gas throttle valve from which, being jacketted wholly or partially for hot water or hot gases. This passage debouches into a manifold chamber communicating with the engine cylinders, and is controlled by a throttle valve of conical piston type. A second passage—that for the air to be added—also debouches into this chamber, and is controlled by a second like piston valve preferably upon the same spindle; the two valves, or the passages they control, being so contoured that in various positions they give those relative proportions of air and gas which have been found to be correct. These valves are operated conjointly through the floating lever and governor device described in the prior specification hereinbefore referred to.

The air passage is further controlled preferably by a piston valve of like form, and this is operatively connected directly to the governor without the interposition of the floating lever device.

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There is further provided an adjustable valve of hit-and-miss or other convenient and simple form, for admitting a certain amount of air between the speed control valve and the ordinary air throttle valve.

Means are provided as usual for operating the air and gas throttle valve independently of the governor mechanism.

Dated this Third day of July, 1908.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Carburettors for Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

That type of carburettor in which a mixture too rich for combustion is diluted with air before it reaches the engine and in which throttling valves control the mixture and the air—which valves have at all positions experimentally determined proportionate openings—is very effective so long as the speed of the engine and the corresponding velocity of gas and air is great enough for there to be throttling action at the valves. But as soon as the air and gas velocities cease to be so sufficient, the action fails, because the proportion of gas falls owing to the greater resistance offered by the jet and gas passages than is offered by the air passages. This disability has been overcome by the provision of a valve controlling the admission of air to a valve conjointly throttling gas and air and controlled in turn by the speed of the engine.

The invention has for its object to provide a simple and effective form of carburettor embodying a simple and effective form of extra air control valve, controlled directly by the speed of the engine and in combination therewith a static adjustable valve supplying to the throttle valve a certain definite and adjustable quantity of air irrespectively of the speed controlled valve and in which the air control valve is directly connected to the governor, while the air-and-gas throttle valve, the supply of air to which it controls is indirectly connected to the governor through a floating lever device after the manner described in the Specification of Murray and Fulton's Patent No. 9251 of 1902.

In order that the invention and the manner of performing the same may be properly understood, there is hereunto appended a sheet of explanatory drawings showing in Figure 1 in sectional elevation and in Figure 2 in sectional plan—both in a measure diagrammatic—an example of this improved and simple carburettor.

In this example, air is drawn through a circumscribed orifice A past a simple float-feed controlled jet nozzle A^1 connected by a tubular passage A^2 at the end of which enlarged and remote from the jet nozzle is a throttle valve B

of conical piston type; the tubular passage A^2 being provided practically throughout its length with a jacket A^3 within which hot water or gases circulate.

Beyond the valve B the passage debouches into a chamber B^1 communicating with the engine cylinders in usual manner by an outlet B^2.

A second passage C—that for the air to be added—also debouches into this chamber B^1 and is controlled by a second piston valve C^1 like and upon the same spindle C^2 as the valve B—the two valves B, C^1, (or it might alternatively be the passages they control—the valves being then cylindrical) being so contoured that in various positions they give those relative proportions of air and gas which have been found to be correct.

The valve spindle C^2 is so controlled by a spring D acting between a collar D^1 on the spindle and a boss D^2 through which the spindle passes so as to tend to close the valves B, C^1, while the lower end of the spindle is engaged by a tappet roller D^3 on the usual floating lever D^4 of the well known control gear described in the prior specification hereinbefore referred to—one end of the floating lever being connected by a link to a hand lever D^5 under control of the operator, and the other end being pivoted on one arm E of a three armed bell-crank lever, the second arm E^1 of which engages the muff E^2 of the governor which may be of that type shown, or of any other convenient type offering sufficient range.

There is also provided for operating the valves B, C^1 a tappet G engaging the collar D^1 and carried on a shaft G^1 rotatable by the operator, so that he may move the valves independently of the governor.

The air passage C in addition to being controlled by the valve C^1 at its outlet end is controlled at its inlet end by a valve H of similar type carried upon a spindle H^1 and directly connected to the governor by a link H^2 between it and the third arm H^3 of the bell-crank lever. The valve H is thus operated by the governor without the interposition of any floating lever control device.

As the amount of air required at the lowest engine speed practicable is quite an appreciable proportion of that required at the highest speed, it obviously simplifies the mechanism if an inlet for this amount of air to the air passage C be provided apart from that controlled by the valve C^1. To this end there is provided a hit-and-miss valve device J at the intake end of the passage C and proportioned when open to admit this amount of air. As will be seen in Figure 2 the valve J is normally held open by the spring J^1, but may be closed (for starting) by the operator pressing the knob J^2.

A hit-and-miss sleeve K is provided below the jet nozzle A^1 for adjusting the amount of air passing thereto, and at the opposite end of the passage A^2 there is provided a bye-pass L past the valve B controlled by a needle-valve L^1 and for like static adjustment.

It is of course obvious that if the valve C^1 be so far closed as to restrict the area there to that of the valve J, the valve H ceases to perform any function—it only performs its function when the area at the valve C^1 is greater than at the valve J; that is under full load conditions.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a carburettor of the type described conjointly operated air and mixture throttling valves connected to a governor through a floating lever hand adjustment device and a valve controlling the admission of air to the air and mixture throttling valve and under the direct control of the governor.

—2— In a carburettor of the type described having conjointly operated air and mixture throttling valves, and a valve controlled by the speed of the engine and controlling the admission of part of the air to the air throttling valve and an aperture normally open admitting the remainder of the air, an arrangement in

which the air and mixture throttling valve is indirectly under the control of a governor, while the valve controlling the admission of air thereto is directly under the control of a governor.

—3— In a carburettor of the type described, in combination, an intake of constricted area about a jet nozzle, a lengthy jacketted passage therefrom and communicating with a chamber, a throttle valve controlling that communication, a second passage also communicating with that chamber and also under control of a throttle valve, both valves being conjointly operated through a floating lever device from a governor and a third valve directly controlled by the governor and controlling the passage to the second throttle valve, as described.

—4— The improved carburettor substantially as hereinbefore described and as shown in the accompanying drawings.

Dated this Thirtieth day of December, 1908.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 25—50/12/1912.]

A.D. 1908. JULY 4. Nº 14,198.

THE ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

(1 SHEET)

(2nd Edition)

FIG. 1.

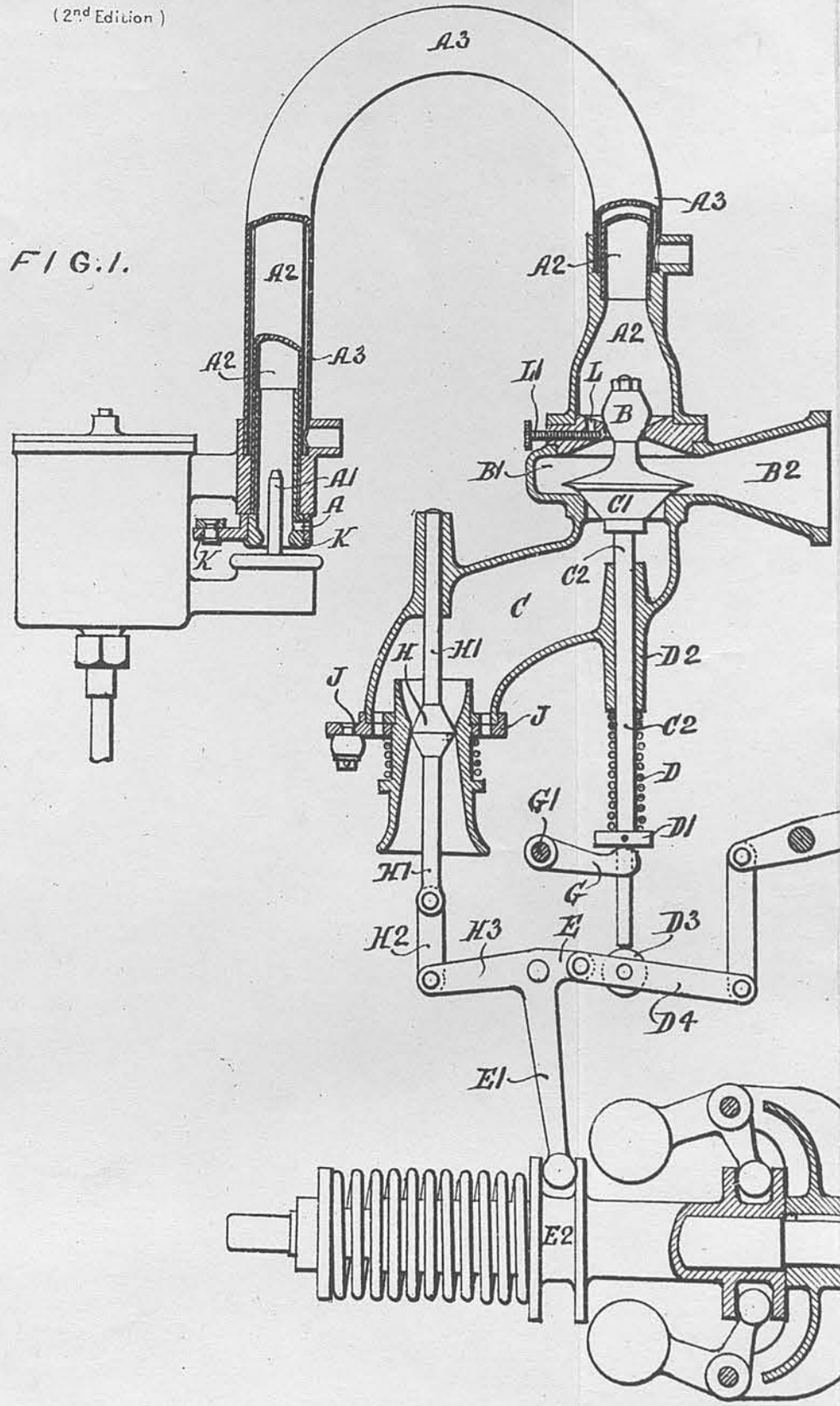
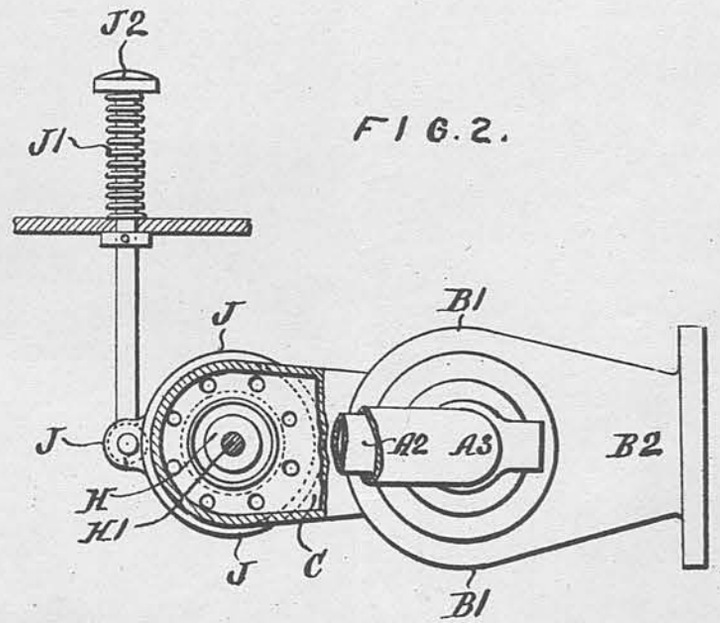


FIG. 2.



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12.

N° 15,584 A.D. 1910

Date of Application, 29th June, 1910

Complete Specification Left, 24th Dec., 1910—Accepted, 9th Mar., 1911

PROVISIONAL SPECIFICATION.

Improvements in Carburettors for Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to carburettors of the type described in our earlier Patent Specification No. 14,198 of 1908, in which there are conjointly operated air-and-mixture throttling valves indirectly connected to and operated by a governor through a hand adjustment device after the manner described in Murray and Fulton's Patent Specification No. 9251 of 1902, and also an extra valve controlling the admission of air to the conjoint air-and-mixture throttling valves and under the direct control of the governor.

In engines fitted with this type of carburettor, there is considerable difficulty of avoiding momentary racing of the engine with light loads and particularly with low speeds, owing to the fact that the conjoint air-and-mixture throttle valves, or the passages they control, must be so formed as whilst avoiding constructional difficulties still give sufficient area to avoid unnecessary throttling at high speeds and full load, consequently an extremely small lift of the conjoint air-and-mixture throttle valves at low speeds, light load, permits such an amount of mixture to pass as causes the engine to accelerate more rapidly than is desirable, and get for the moment beyond the control of the governor.

To overcome this objection and incidentally to take the place, with advantage, of the usual hand adjusted by-pass valve hitherto desirable for light loads, according to the present invention, there is provided a pilot valve to control a port permitting mixture past the mixture throttle valve. When full open this pilot valve just passes rather more than sufficient mixture to run the engine at a low speed with a light load. It is controlled in a similar fashion, and by the mechanism controlling the conjoint air-and-mixture throttle valves, but it is so arranged that when the conjoint valves have just come to their seats, it is still to all intents and purposes just full open, and allows only the amount of mixture to pass which ensures the best running of the engine under the circumstances referred to, racing being prevented, as immediately speed increases (the governor control lever not having meanwhile been hand adjusted) the governor acts to close the pilot valve. That is to say, this pilot valve takes up the control where the mixture throttle valve leaves off. It also avoids the necessity for a by-pass valve, over which it has an additional advantage, that when the vehicle is driving the engine, and the engine therefore is acting as a brake, the governor then entirely shuts off all fuel supply to the engine, with a resulting increased economy.

The pilot valve is preferably of a simple conical type, so that it controls only the passage of mixture, or it may be of a double beat type, like the conjoint air-and-mixture throttle valve, in which case it will also control the passage of air past the air throttle valve.

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PRICE 6d.

If desired, an adjustable or controlled by-pass for pure air may also be provided past the main air throttle valve, but still in such a position as to be ineffective when it is desired to close all ingress of air for starting purposes.

Dated this Twenty eighth day of June, 1910.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Carburettors for Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to carburettors of the type described in our earlier Patent Specification No. 14,198 of 1908, in which there are conjointly operated air-and-mixture throttling valves indirectly connected to and operated by a governor through a hand adjustment device after the manner described in Murray and Fulton's Patent Specification No. 9251 of 1902, and also an extra valve controlling the admission of air to the conjoint air-and-mixture throttling valves and under the direct control of the governor.

In engines fitted with this type of carburettor, there is considerable difficulty in avoiding momentary racing of the engine with light loads and particularly when running at low speeds, owing to the fact that the conjoint air-and-mixture throttle valves, or the passages, they control, must be so formed as to avoid throttling at high speeds and full load, consequently an extremely small lift of the conjoint air-and-mixture throttle valves when the engine is running at low speeds and with light load, permits such an amount of mixture to pass as causes the engine to accelerate more rapidly than is desirable, and go for the moment beyond the control of the governor.

To overcome this objection and incidentally to take the place, with advantage, of the usual hand adjusted by-pass valve hitherto desirable for light loads according to the present invention, there is provided a pilot valve to control a port permitting the flow of mixture to pass the mixture throttle valve. When full open this pilot valve just passes rather more than sufficient mixture to run the engine at a low speed with a light load. It is controlled in a similar fashion, and by the mechanism controlling the conjoint air-and-mixture throttle valves, but it is so arranged that when the conjoint valves have just come to their seats, it is still to all intents and purposes just full open, and allows only the amount of mixture to pass which ensures the best running of the engine under the circumstances referred to, racing being prevented, as immediately speed increases (the governor control lever not having meanwhile been hand adjusted) the governor acts to close the pilot valve. That is to say, this pilot valve takes up the control where the mixture throttle valve leaves off. It also avoids the necessity for the usual hand adjustable by-pass valve hitherto desirable for light load running, over which it has an additional advantage, that when the vehicle is driving the engine, and the engine therefore is acting as a brake, the governor then entirely shuts off the fuel supply to the engine, with a resulting increased economy.

The pilot valve is preferably of a simple conical type, so that it controls only the passage of mixture, or it may be of a double beat type, like the conjoint air-and-mixture throttle valve, in which case it will also control the passage of air past the air throttle valve.

If desired, an adjustable or controlled by-pass for pure air may also be provided past the main air throttle valve, which valve may be closed when it is desired to close all ingress of air for starting purposes.

In order that the invention and the manner of performing the same may be properly understood there are hereunto appended two sheets of explanatory drawings in which Figure 1, Sheet 1, is a sectional elevation of parts sufficient to show one example of the invention, Figure 2 being an elevation at right angles to Figure 1 of certain of these parts, whilst Figure 3, Sheet 2, is a sectional elevation showing a second example.

In carrying out the invention according to the example shown in Figures 1 and 2, the end of the passage A^2 leading from a jet device (not shown) is controlled by a throttle valve B. Beyond the valve the passage communicates with the engine cylinders in usual manner by outlets B^2.

A second passage C—that for the air to be added—also debouches into the outlets B^2, the communicating port being controlled by a conical valve C^1 upon the same spindle C^2 as the throttle valve B. A spring D, acting between a collar D^1 on the spindle C^2 and a boss D^2 through which the spindle passes, tends to close the valves B, C^1. The end of the spindle is engaged by a tappet roller D^3 on a transverse bolt L extending through the sides of a U-shaped floating lever D^4. The ends of this lever are pivoted to a lever L^1 on a spindle D^5 adjustable by hand, the round-ended part of the floating lever being pivoted to a rod E^1 operated by a governor (not shown). The construction thus far described being all substantially disclosed in the two earlier specifications hereinbefore referred to.

According to this example of the present invention there is provided an additional and pilot valve M of conical form controlling a port giving a passage for mixture past the throttle valve B from the passage A^2 to the outlets B^2 leading to the engine cylinders. The spindle M^1 of this valve M passes through the boss D^2, and a spring M^2, acting between a collar M^3 on the spindle and the boss, tends to keep the valve M closed. The valve M is controlled in a similar fashion to, and by the mechanism controlling the conjoint air-and-mixture valve B, C^1, there being provided for this purpose a second tappet roller N on the bolt L carried by the floating lever D^4.

The parts are so positioned that when the conjoint valves B, C^1 have just come to their seats the pilot valve M is still full open and allows only the amount of mixture to pass which ensures the best running of the engine under the circumstances referred to, that is with light loads and particularly at low speeds. At the same time the possibility of the engine racing under these circumstances is prevented, as immediately speed increases (the lever L^1 not having meanwhile been hand adjusted) the governor acts, through the rod E^1, to so raise the floating lever D^4 that the tappet roller N is removed from contact with the spindle M^1 of the pilot valve M and the spring M^2 at once causes that valve to close on its seat. It will thus be seen that the pilot valve M takes up the control where the combined air-and-mixture throttle valves B, C^1 leave off. The pilot valve also obviates the necessity to provide the usual hand adjustable by-pass valve, over which it has an additional advantage, that when the vehicle is driving the engine and the engine is therefore acting as a brake, the governor then entirely shuts off all fuel supply to the engine with a resulting increase of economy.

According to the alternative example of the invention shown in Figure 3, the pilot M and its spindle M^1 are arranged concentrically within the main valve B, C^1 and its spindle C^2. The spring M^2 tending to keep the pilot valve closed on its seat extends between the under side of the pilot valve and the

upper side of a plug N^1 closing an opening through the main valve. In this example one tappet roller D^3 on the floating lever D^4 operates both the pilot and main valves, the pilot valve spindle M^1 projecting beyond the other spindle C^2 so that the tappet roller, acting first on the pilot valve spindle, opens the pilot valve by the amount its spindle projects before commencing to act on the main valve spindle, and inversely keeps the pilot valve open after the main valve is closed to allow only the amount of mixture to pass which ensures the best running of the engine under the circumstances hereinbefore referred to. The mixture from the passage A^2 passes by ports P in the spindle C^2 into an annular space P^1 surrounding the lower part of the pilot valve spindle M^1, which is reduced in diameter at this part, and when the pilot valve M is open this mixture passes from the interior of the main valve B C^1 through ports P^2 therein to the outlets B^2.

If desired the pilot valve may be of double beat type like the conjoint air-and-mixture throttle valve B, C^1, in which case it will also control the passage of air past the air throttle valve C^1.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— The combination with a carburettor of the type described of a pilot valve so operated by the mechanism operating the conjoint air-and-mixture throttle valve of the carburettor that when the conjoint valve is just closed the pilot valve is practically full open, continued movement of the mechanism finally closing it also, as and for the purposes set forth.

—2— In the carburettor forming the subject-matter of the foregoing claim hereof, a pilot valve controlling a port permitting the flow of mixture to pass the mixture throttle valve, the pilot valve being actuated by a spring on the spindle of the pilot valve and a tappet roller on the hand adjustable governor operated floating lever of the carburettor as described.

—3— In the carburettor forming the subject-matter of Claim 1 hereof, a single or double beat pilot valve within the conjoint air-and-mixture throttle valve, and controlling ports permitting mixture or mixture and air to the interior of the conjoint valve and from thence to outlets communicating with the engine cylinders, the pilot valve being actuated by a spring and the mechanism operating the conjoint valve, as described.

Dated this Twenty third day of December, 1910.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1911.

A.D. 1910. JUNE 29. N°. 15,584.

ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

(2 SHEETS)

SHEET 1.

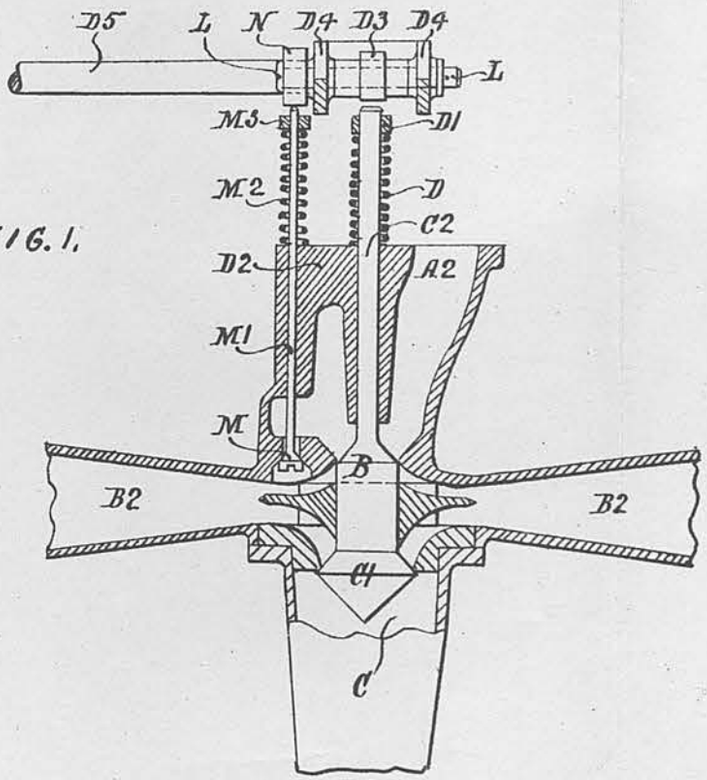


FIG. 1.

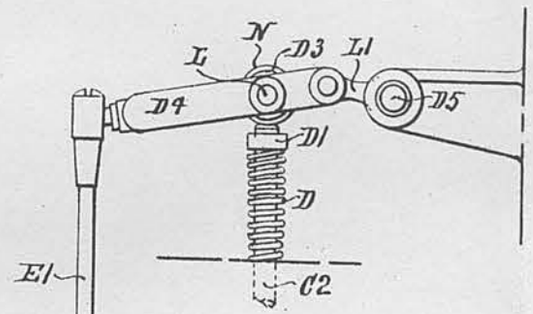
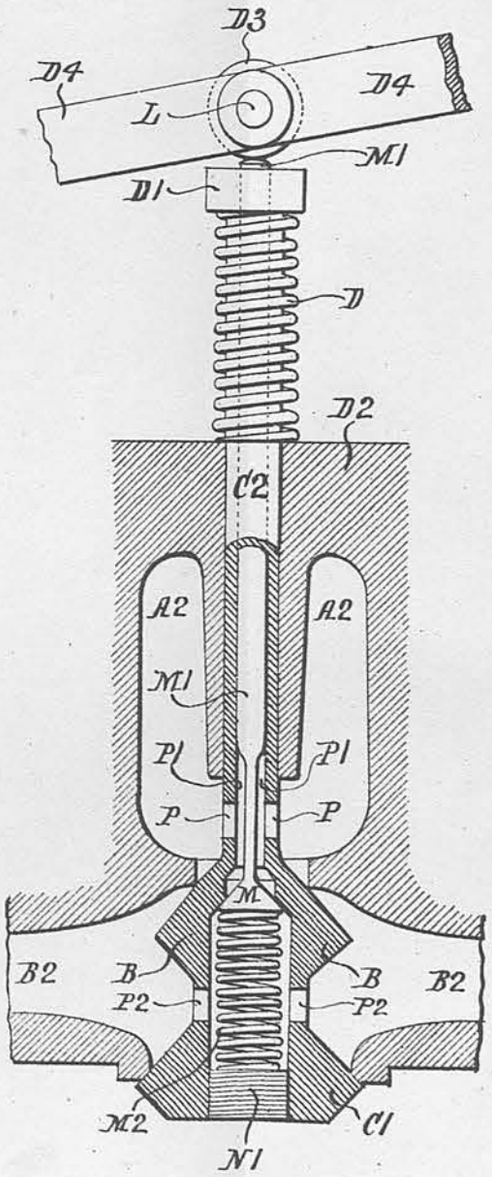


FIG. 2.

SHEET 2.

FIG. 3.



[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

N° 27,073 A.D. 1911

Date of Application, 4th Dec., 1911

Complete Specification Left, 25th May, 1912—Accepted, 4th Dec., 1912

PROVISIONAL SPECIFICATION.

Improvements in connection with Carburettors for Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

In carburettors in which there are valves one controlling the admission to the induction pipe of gas—that is rich mixture—and another air for diluting that mixture, (such for example as described in the Specification of our prior Patent No. 14,198 of 1908) control is not entirely effective under ordinary conditions and widely varying speed and power, because there is, for example, at high speed and light load great difference in pressure between the inlet and outlet sides of these valves and the relative openings of them because of the high fluid velocities equivalent to these pressures become so microscopically minute, that its maintenance in proper adjustment is a practical impossibility under ordinary running conditions.

The invention has for its object to obviate these disabilities.

According to the invention, the gas and air valves are arranged in series, that is to say, the gas valve, at all times of effective area greater than the air valve—that is to say, of an area effectively greater relatively to the fluid velocities at the two valves—is the ultimate control of both gas and air to the engine while the air valve controls the supply of air reaching the mixing chamber the outlet from which is controlled by the gas valve.

The air valve admits air to the mixing chamber the discharge of mixture from which to the induction pipe is controlled by the gas valve.

The supply of air to the air valve is controlled by what may be termed a speed air control valve operating in a chamber—an antechamber to the mixing chamber—and communicating therewith it may be by a port or ports of determinate or permanently adjustable area. The speed air control valve controls the admission of air to this chamber either entirely or beyond a certain amount free to enter by ports of determinate or permanently adjustable area.

The speed air control valve is directly operated by a governor or equivalent speed actuated device. Thus there are three valves in series first, a speed air controlling valve controlling the admission of more than a certain amount of air to the antechamber, the outlet from which is controlled by the air valve proper, the outlet side of which is in communication with the main mixture chamber, the outlet from which is controlled in turn by the third valve of the series—the gas valve.

Air valve proper and gas valve may be conjointly operated, and there may be combined with them a pilot valve device, of the type described for example in the Specification of our prior Patent No. 15,584 of 1910. Very conveniently the two valves may be upon one stem, and be in equilibrio. Preferably also they are indirectly controlled by a governor, that is to say through the now

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well-known hand-and-governor floating lever device, but they may be controlled by hand alone.

With the improved arrangement of valves in series it is quite apparent that the pressure difference on opposite sides of the valves which control the proportions of the mixture, that is other than the gas valve, is much reduced, the fluid velocity past them is therefore much less, and the area for a given volume much greater. Therefore, what may be termed the mechanical error of adjustment is much reduced.

Dated this Second day of December, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in connection with Carburettors for Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to the type of carburettor—for example such as that described in the Specification of our prior Patent No. 28,362 of 1904—in which the gas and air valves are arranged in series, that is to say, the gas valve, at all times of effective area greater than the air valve is the ultimate control of both gas and air to the engine, while the air valve controls the supply of air reaching the mixing chamber the outlet from which is controlled by the gas valve, the gas being a constant mixture not controllable while the carburettor is in operation.

The air valve admits air to the mixing chamber the discharge of mixture from which to the induction pipe is controlled by the gas valve.

The invention has for its object to provide an improved form of valve for such a carburettor—the improved form avoiding the disabilities—such as on the one hand excessive leakage, or on the other hand such stiffness as to render governor control impracticable—of sliding piston or rotary sleeve valves hitherto used.

The improved valve is of mushroom or tappet type, and comprises essentially the valve body coacting with two seats—the lesser seat controlling air, while the greater controls gas. While preferably the body of the valve so extends through the air inlet seat as to provide an annular area less than the area which would normally be afforded by the full opening of the air valve.

The supply of air to or from the air valve may be controlled by what may be termed a speed air control valve operating in a chamber—an antechamber to the mixing chamber—and communicating therewith it may be by a port or ports of determinate or permanently adjustable area. The speed air control valve controls the admission of air to or from this chamber.

The speed air control valve may be directly operated by a governor or equivalent speed actuated device, or may be an automatic valve. Thus there are as in some known constructions three valves in series, first, a speed air controlling valve controlling the admission of more than a certain amount of

air to or from the antechamber, the outlet from which is controlled by the air valve proper, the outlet side of which is in communication with the main mixture chamber, the outlet from which is controlled in turn by the third valve of the series—the gas valve.

Alternatively, constricted ports or passages leading to or from the speed air control valve and acting conjointly with that valve may be provided. Or for the sake of simplicity such constricted ports or passages may take the place of the speed air valve. Or again, for still greater simplicity, the speed air control valve or its partial equivalent of constricted ports or passages may be dispensed with and air have uncontrolled admission to the air valve proper—but of course the greatest advantage is to be found in the use of the complete combination.

There may be combined with the combined air and gas valve a pilot valve device, of the type described for example in the Specification of our prior Patent No. 15,584 of 1910. The valves are indirectly controlled by a governor, that is to say through the now well-known hand-and-governor floating lever device, but they may be controlled by hand alone.

In order that the invention and the manner of performing the same may be properly understood there are hereunto appended two sheets of explanatory drawings illustrating two examples of carburettor control-valve arrangements embodying the features of the invention hereinbefore set forth, Figures 1 and 2 Sheet 1 being vertical sections at right angles to one another of one example, and Figure 3 Sheet 2 a vertical section of the other example.

In the example shown in Figures 1 and 2 the gas valve A and the air valve proper B are on one stem or body C, and are of the improved mushroom form. At the upper end of the integer is formed a guide piston C^1 moving in a chamber D between the cover D^1 of which and the piston is a spring C^2 tending to keep the valves on their seats.

There is a gas passage A^1 from the usual jacketed vaporising chamber A^2 in which is the petrol jet A^3 surrounded by a choke tube A^4. The outlet from this gas passage A^1 to a mixture passage E, whence the mixture passes to the engine, is controlled by the gas valve A.

Beneath the gas passage A^1 is an air passage B^1. Outlet from this air passage to the gas passage A^1 is controlled by the air valve proper B. Inlet to the passage B^1 is controlled by the speed air valve F on a spindle F^1 and which is normally kept on its seat by a spring F^2 acting between it and a cap in a chamber F^3 to which air has free access by apertures F^4.

Centrally within the mushroom gas-and-air-valve integer is the pilot valve G of the prior patent hereinbefore referred to and the functions of which are fully set forth in the specification of that patent. It is carried upon a spindle G^1.

The air-and-gas valve integer, the speed air valve F, and the pilot valve G, are all operated by the now well-known hand-governor floating lever control which in the present instance consists of a three armed lever pivoted on the casing, one arm H operated by a rod H^1 from the governor or other speed device, a second arm H^2 bearing a roller H^3 engaging the spindle F^1 of the speed air valve F (thus that valve is operated directly by the governor) and the third arm H^4 connected to one end of a floating lever J the other end of which is connected by a link J^1 to a hand lever J^2 adjustable around a quadrant J^3. A roller J^4 on the lever J engages the spindle of the pilot valve G, and also the stem C, of the air-and-gas integer—the first upward movement of the roller J^4, owing to the slightly greater length of the pilot valve spindle G^1, first raising this spindle the necessary amount and continued movement then raising stem C, and spindle G^1 together.

Apart from non essential differences in form and design which are obvious and need not be touched upon, the example shown in Figure 3 differs from that just described in that the governor-operated speed air valve F is dispensed with. Its place is taken by the combination of long constricted passages K forming

communication between the space B^1 and the mixture passage E, which passages are further controlled by a light automatic valve K^1 closing the upper ends of the passages and under control of a light spring K^2. It will be seen that the passages K and valve K^1 control the air passing from the air valve B, and not as the valve F in the former example to that valve. The passages K and valve K^1 may however be arranged to control the air passing to the valve B (the construction of the device being modified accordingly), or alternatively, the speed air valve F may control the issue of air from the air valve B. The pilot valve device is also dispensed with.

It will be seen, then, that this second example is a simplification of the first example. The essential feature of the invention is the form of the combined gas and air valve integer, the gas valve offering a passage as already stated at all times of an area effectively greater than that of the air valve passage. There may be combined with this, firstly a governor operated speed air valve, an automatic speed air valve, (that is a valve automatically opening under increased suction due to increased speed), or a constricted passage or series thereof taking the place of the latter or used in combination therewith, and finally there may be combined in any of the arrangements a pilot valve device.

With the arrangement of improved valves in series it is quite apparent that the pressure difference on opposite sides of the valves which control the proportions of the mixture, that is other than the gas valve, is much reduced, the fluid velocity past them is therefore much less, and the area for a given volume much greater. Therefore, what may be termed the mechanical error of adjustment is much reduced.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a carburettor control valve arrangement comprising gas and air valves arranged in series, a conjoint air and gas valve integer of mushroom type having two mushroom faces one coacting with a gas or mixture outlet seat, the other with an air inlet seat, as described.

—2— In combination with the subject-matter of Claim 1 hereof, a valve controlling in known manner the supply of air to or from the air valve and under control of a governor or other speed responsive device.

—3— In combination with the subject-matter of Claim 1 hereof, an automatic valve controlling in known manner the supply of air to or from the air valve.

—4— In combination with the subject-matter of Claim 1 hereof, a long or constricted passage or passages controlling the supply of air to or from the air valve with or without an automatic valve controlling the outlet from the passage or passages.

—5— In combination with the subject-matter of the foregoing claims hereof, the pilot valve device hereinbefore referred to.

—6— In combination with the subject-matter of the foregoing claims hereof, means for operating the valves comprising a floating lever conjoint hand and governor operated device, substantially as described.

—7— The carburettor control valve arrangement substantially as hereinbefore described with reference to Figures 1 and 2 and to Figure 3 of the accompanying drawing.

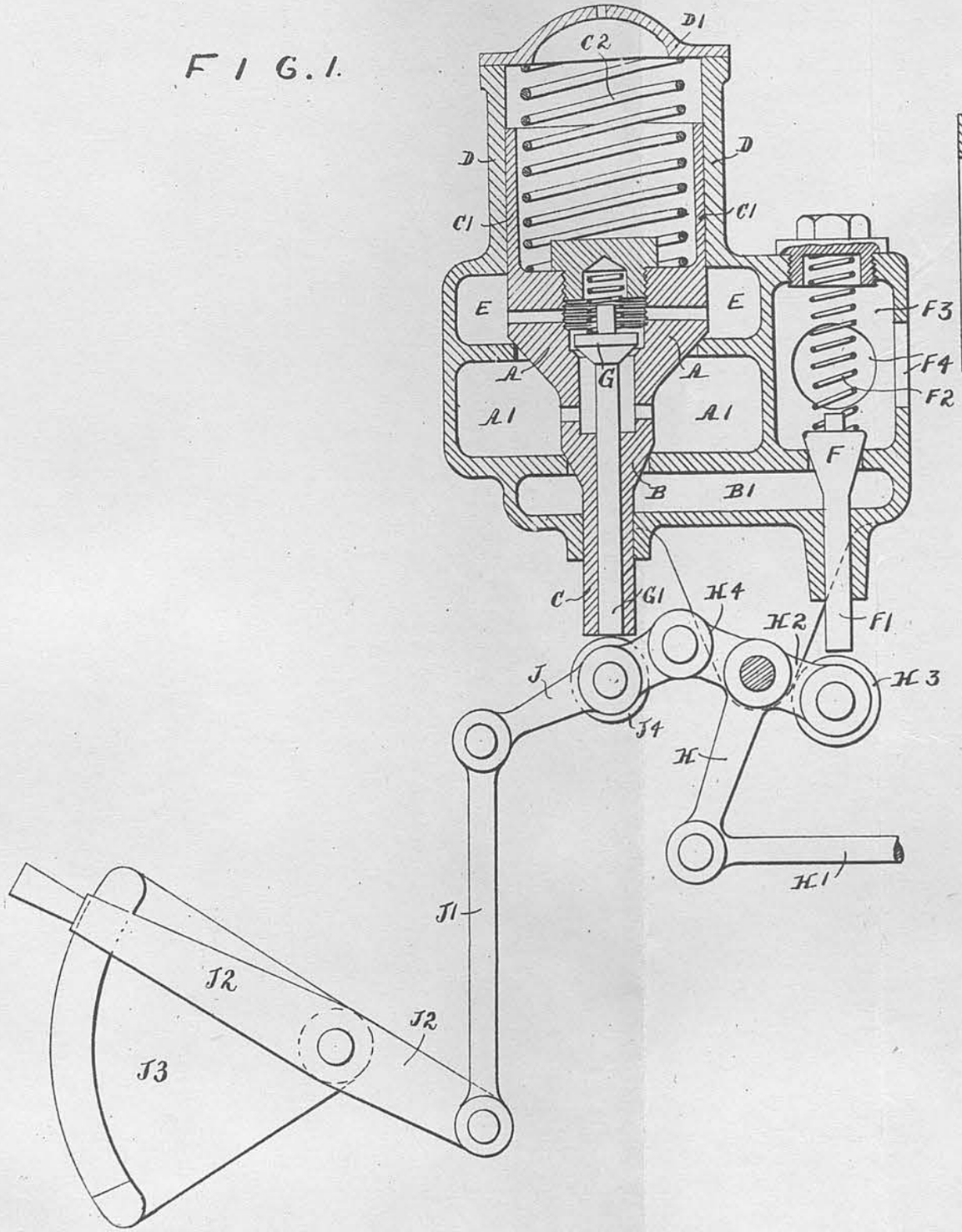
Dated this Twenty-fourth day of May, 1912.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

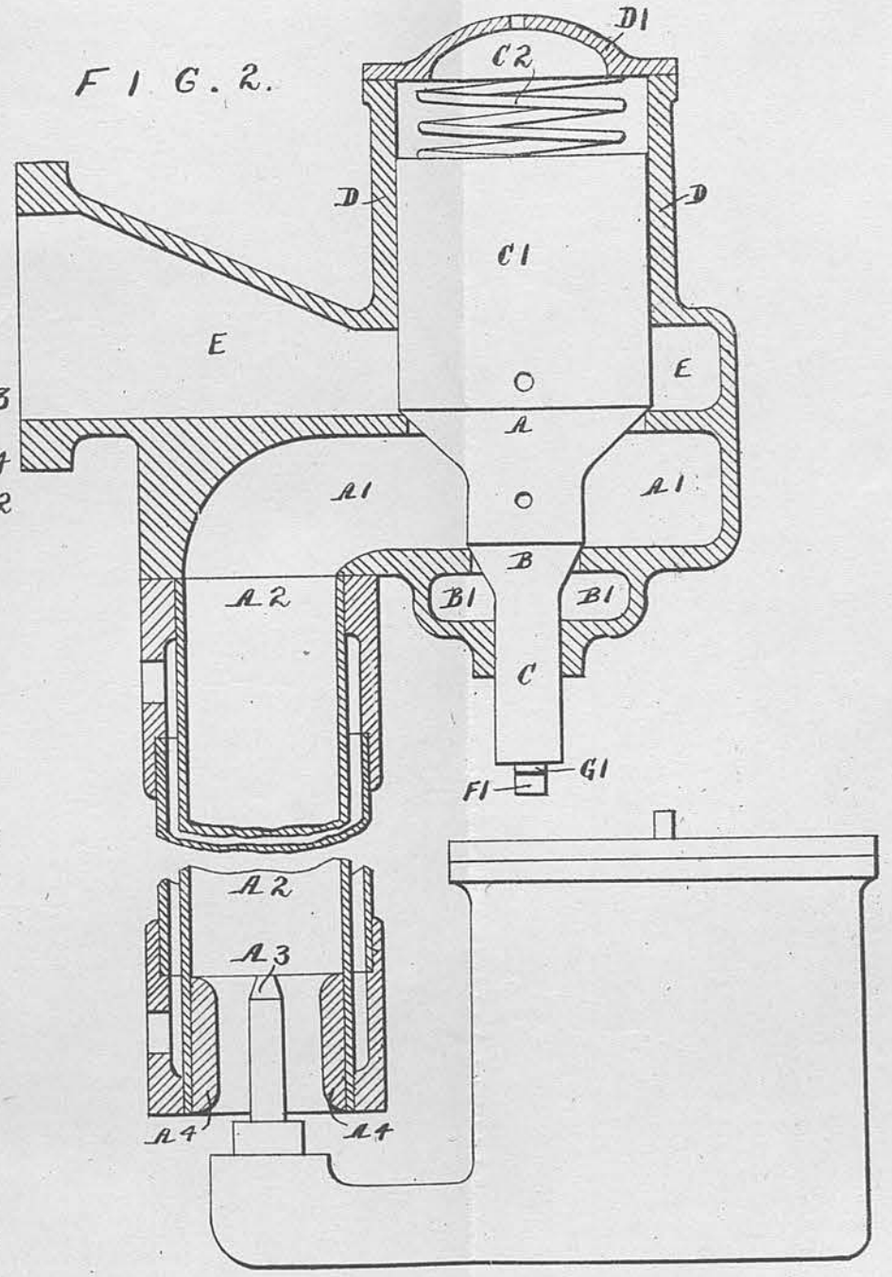
Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

[This Drawing is a reproduction of the Original on a reduced scale.]

F I G. 1.



F I G. 2.



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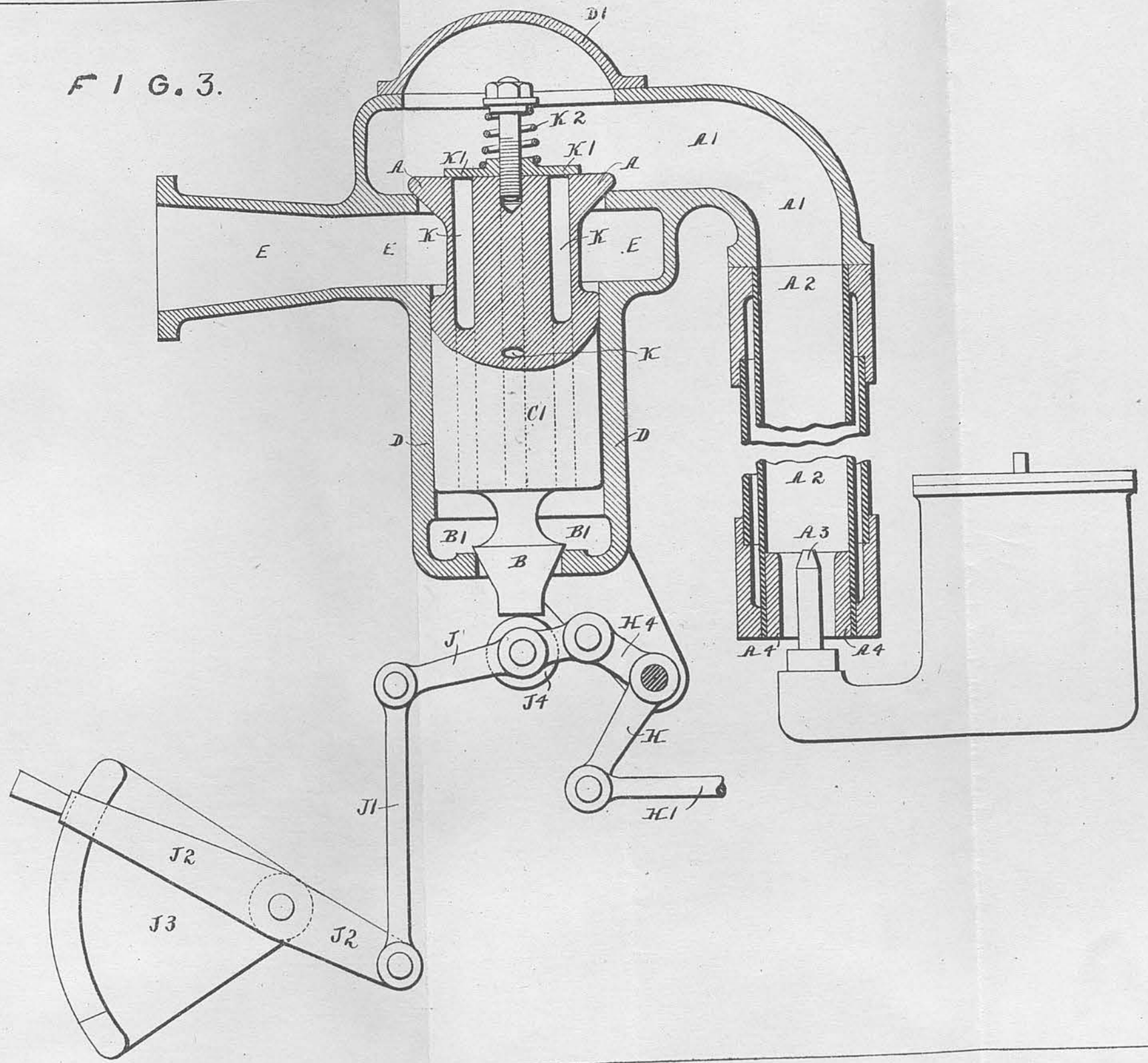
[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 3.



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14

N° 20,980 A.D. 1913

Date of Application, 17th Sept., 1913

Complete Specification Left, 14th Mar., 1914—Accepted, 3rd Sept., 1914

PROVISIONAL SPECIFICATION.

An Improved Carburettor for use with Paraffin or the like in Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the City and County of Glasgow, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention relates to carburettors for use with paraffin and like fuels of medium density in internal combustion engines, and has for its object to provide an apparatus in which, firstly, air and fuel are automatically measured in their due proportions to form the mixture, secondly, the fuel is broken up into a fine spray by an air jet device in which is used only that air already measured along with the fuel which it now atomises, thirdly, the measured and atomised fuel and the measured air are led through a superheating chamber in which they are as far as possible converted into gas, and, fourthly, it may be there is added under hand, or under governor control, or jointly, an amount of additional air for dilution of the mixture.

In the improved carburettor the measurement of the air and the fuel may be very conveniently effected by the suction of the engine drawing in either hot or cold air through an orifice or *vena contracta* of determined area, the fuel supply being introduced at or about the constriction, the amount of fuel of course depending upon the reduction of pressure due to the wire drawing of the air and the area of the fuel nozzle, but as it is not particularly desired to spray the fuel at this point, the measuring aperture in the fuel pipe may conveniently be kept some distance from its debouchment into the *vena contracta*.

The carburettor is so arranged that the fuel will flow by the combined action of the inrushing air and gravity to the spraying device.

While any convenient form of air and liquid spraying device may be used, there is according to the invention preferably provided a small sump or cup into which the fuel is delivered by any convenient form of measuring device in which the flow of fuel is regulated in accordance with the flow of air induced by engine suction—for example by a choke tube of ordinary form in which is a fuel jet orifice preferably so positioned or shielded that spraying is not induced to any extent but the fuel rather flows from it to the sump in a quiescent stream. To this end the actual jet orifice may be arranged considerably beneath an upward tubular extension which extension becomes filled with fuel flowing through the jet orifice and passing over its edge to the sump.

The sump is enclosed in a casing to which only that air measured relatively to the fuel by its passage through the choke tube is admitted.

In the sump and passing normally below the surface of the fuel there is a jet nozzle. To this nozzle air drawn from the sump chamber is delivered by any convenient form of pump—a reciprocating pump delivering impulses of air, or a rotary pump delivering a more or less constant stream. By these means is the fuel exceedingly effectively atomised and mixed with the air.

From the sump chamber the mixture passes to a super-heating chamber of

any convenient form heated in any convenient manner—by exhaust gases, for example.

From the sump chamber the gasified mixture passes to a chamber in which there may be admixed with it a further amount of air supplied under hand, or governor, or joint control. This control and the throttling device may very conveniently be such as are described in the specifications of the present applicants' many prior patents.

From the mixing chamber the gasified and diluted mixture passes to the engine.

Dated this Sixteenth day of September, 1913.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

An Improved Carburettor for use with Paraffin or the like in Internal Combustion Engines.

We, Albion Motor Car Company, Limited, of South Street, Scotstoun, in the County of Renfrew, North Britain, and Thomas Blackwood Murray, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to carburettors for use with paraffin and like fuels of medium density in internal combustion engines, and has for its object to provide an apparatus in which, firstly, air and fuel are measured in their due proportions to form the mixture and automatically by and in accordance with the inductive demand of the engine, the measured air and fuel being delivered into an enclosed chamber, secondly the fuel is broken up into a fine spray by the action of an air pump which draws its charge from the said measured air in this chamber and compresses it and forces it through a spray making device in which the said measured fuel is caught up and atomised by the action of the said compressed air, thirdly, the measured and atomised fuel and the measured air are led through a superheating chamber in which they are as far as possible converted into gas, and fourthly, it may be there is added under hand or under governor control, or jointly, an amount of additional air for dilution of the mixture.

In the improved carburettor the measurement of the air and the fuel may be very conveniently effected by the suction of the engine drawing in either hot or cold air through an orifice, or *vena contracta* of determined area, the amount of fuel of course depending upon the reduction of pressure due to the wire drawing of the air and the area of the fuel nozzle, but as it is not particularly desired to spray the fuel at this point, the measuring aperture in the fuel pipe may conveniently be kept some distance from its debouchment into the *vena contracta*.

The carburettor is so arranged that the fuel will flow by the combined action of the inrushing air and gravity to the spraying device.

According to the invention there is provided a small sump or cup into which the fuel is delivered by any convenient form of measuring device in which the flow of fuel is regulated in accordance with the flow of air induced by engine suction—for example by a choke tube of ordinary form in which is a fuel jet orifice preferably so positioned or shielded that spraying is not induced to any

extent, but the fuel rather flows from it to the sump in a quiescent stream. To this end the actual jet orifice may be arranged considerably beneath an upward tubular extension, which extension becomes filled with fuel flowing through the jet orifice and passing over its edge to the sump.

The sump is enclosed in a casing to which only that air measured relatively to the fuel by its passage through the choke tube is admitted.

In the sump and passing normally below the surface of the fuel there is a jet nozzle. To this nozzle air drawn from the sump chamber is delivered by any convenient form of pump—a reciprocating pump delivering impulses of air, or a rotary pump delivering a more or less constant stream. By these means is the fuel exceedingly effectively atomised and mixed with the air.

From the sump chamber the mixture passes to a superheating chamber of any convenient form heated in any convenient manner—by exhaust gases, for example.

From the superheating chamber the gasified mixture passes to a chamber in which there may be admixed with it a further amount of air supplied under hand, or governor, or joint control. This control and the throttling device may very conveniently be such as are described in the specifications of the present applicants' many prior patents.

From the mixing chamber the gasified and diluted mixture passes to the engine.

In sectional elevation in Figure 1 Sheet 1, and in like view in Figure 2 Sheet 2 of two accompanying sheets of drawings are shown two methods of carrying out the invention.

In the example shown in Figure 1 measurement of the air—its amount being proportioned to the demand by reasons of its increased velocity due to the increased suction of increased demand—is accomplished by an inlet passage A. In this passage is a channel B communicating by passages C with a jet nozzle D float fed with fuel from a chamber E and so placed that the air rushing through the passage A causes the fuel to flow into the channel B in volume proportionate to the velocity of the air. No spraying action takes place at this point, but the fuel now flows from the channel B into a sump F in an enclosed chamber G. Into this sump and beneath the normal level of the fuel, there projects a jet nozzle H fed with air. This air is that entering by the inlet passage A, and is drawn through a port J past a non-return valve K by the reciprocating plunger L of a pump M, and is delivered therefrom through a port N past a non-return valve O to the jet nozzle H, and passing out therethrough sprays the fuel in the sump F. Thus the air used for spraying is that measured by the constriction of the passage through which it enters the carburettor and merely passes in a closed cycle from the chamber G through the pump and back to the chamber.

Obviously, any convenient form of pump reciprocating or rotary other than that shown may be used.

From the chamber G the now formed mixture passes to a superheater which may be of any convenient form. That shown consists of a casing P exhaust jacketted and having a portion with internal gills R and a portion through which pass tubes S in internal communication with the jacket. It will be seen that this superheater embodies two known types with the advantage of both—the massive gilled part which serves for storage of considerable heat for use when the engine is much throttled, or is being driven instead of driving, and the tubular part in which the walls of the tubes being thin and constructed of a high heat conducting metal rapidly transfer the heat from the exhaust gases to the mixture, so that there is rapid response to engine load fluctuation.

The example shown in Figure 2 only differs from that described in that more elaborate means are provided for the measurement of fuel in accordance with the demand and for its spraying. In this example the air jet nozzle H projects upwards into the sump F and is enclosed by a cap H^1 pierced with apertures

H^2, H^3, the fuel being drawn into the cap from the sump through the apertures H^3 and ejected in spray through the aperture H^2 by the air jet. The flow of fuel to the sump is controlled by a valve E^1 normally closed operating in an aperture in the floor of the float chamber E, a chamber E^{10} beneath which is connected by a pipe E^3 with the sump F. The spindle E^2 is operatively connected to a diaphragm E^4 in a chamber E^5 through which it passes out, and is controlled by a spring E^6 arranged between the chamber and an adjustable nut E^7 on the spindle. The under side of the diaphragm is in communication with the chamber G by way of a pipe E^{11}, and with the float chamber E by way of an aperture E^8 in the chamber E^5. The upper side of the diaphragm is in communication with the atmosphere by way of an aperture E^9 in the chamber E^5. In operation, increased suction due to increased demand in the chamber G draws down the diaphragm, opens the valve E^1 and admits more fuel to the sump F, and *vice versa*, while the pressure in the float chamber E is equalised with that in the chamber G by the aperture E^8. The valve E^1 is of course empirically contoured to give correct mixture of fuel with the air.

Since the pressures in the sump and in the float chamber are equalised, the velocity of flow of the fuel is constant, and is that due to the hydraulic head in the float chamber—the amount of fuel flowing being determined by the valve E^1.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a carburettor for the purpose set forth means for firstly measuring air and fuel in due mixture proportion and automatically by and in accordance with the inductive demand of the engine, the said measured fuel and air being delivered into an enclosed chamber, secondly, an air pump which draws its charge from the said measured air in this chamber and compresses it and forces it through a spray making device in which the said measured fuel is caught up and atomised by the action of the said compressed air, thirdly, means for superheating the atomised fuel and air as set forth, and fourthly, means for adding, if required, a definite further amount of air to the mixture before it passes into the engine.

—2— In apparatus forming the subject-matter of the foregoing claims hereof, an inlet passage admitting air to a chamber, a float fed fuel jet nozzle arranged below that passage and in communication with it in suchwise that air flowing through the passage causes fuel to be drawn into it also.

—3— In apparatus forming the subject-matter of Claims 1 and 2 hereof, a sump, a float chamber feeding said sump, a valve controlling said feed, and means for operating the valve to vary the feed in accordance with fluctuations in air pressure due to varying demand.

—4— In apparatus forming the subject-matter of the foregoing claims hereof, an exhaust heated superheater, one part massive and of considerable thermal storage capacity, and another part of small mass and high conductivity, as and for the purposes set forth.

—5— The improved carburettor for the purpose set forth substantially as hereinbefore described with reference respectively to Figure 1 and to Figure 2 of the accompanying drawings.

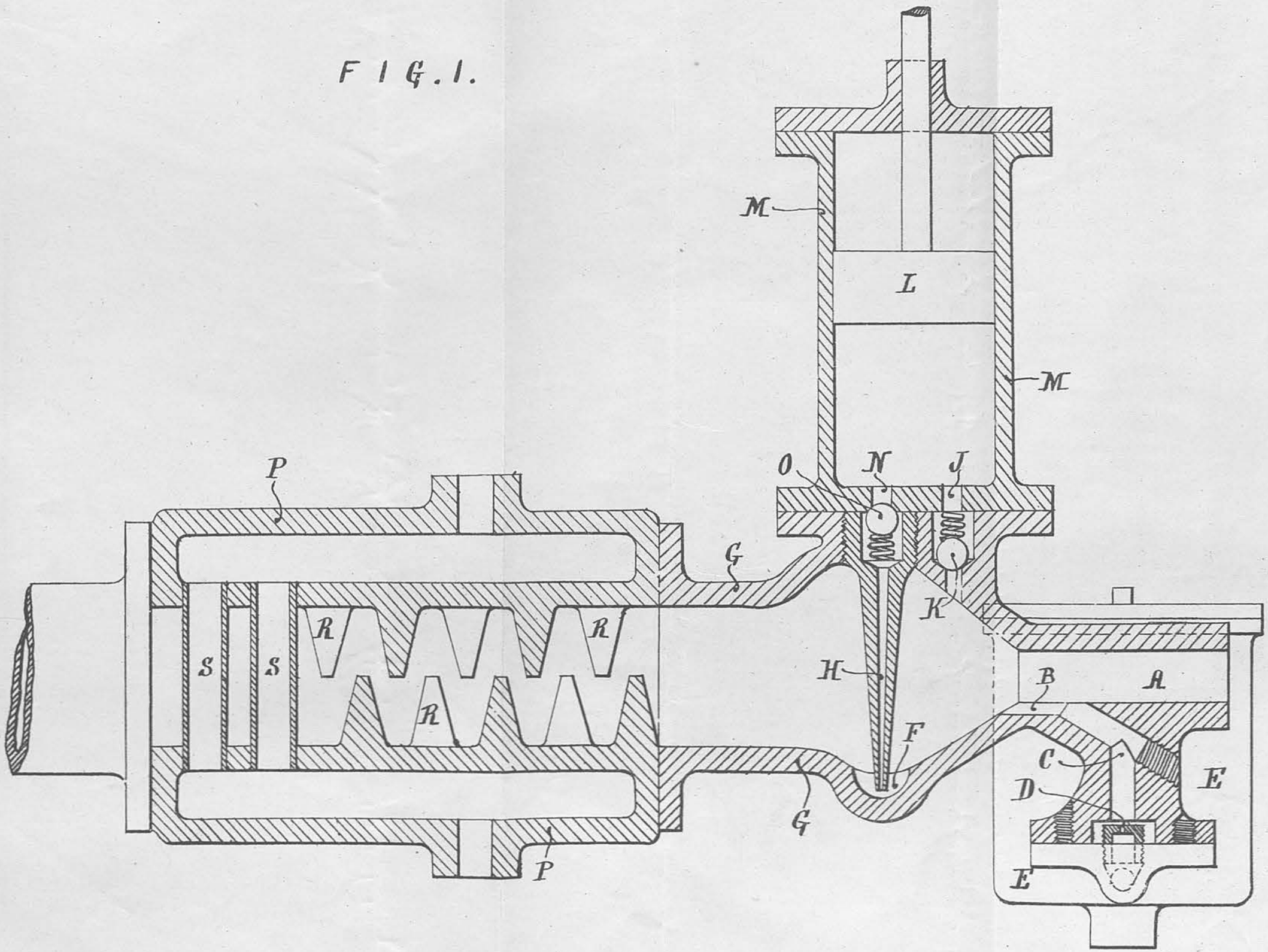
Dated this Thirteenth day of March, 1914.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1914.

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.



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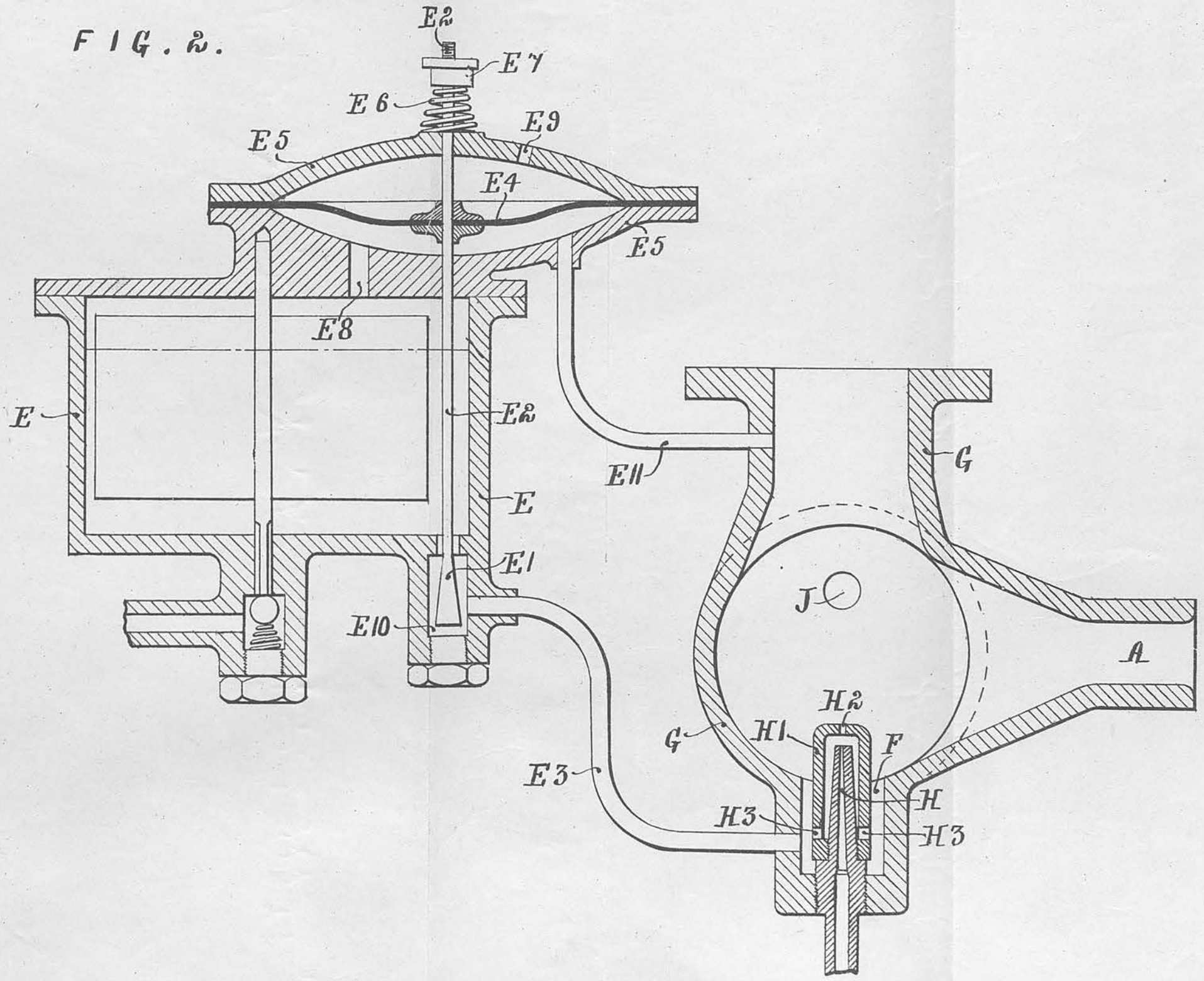
[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 2.



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15.

N° 13,210 A.D. 1904

Date of Application, 11th June, 1904

Complete Specification Left, 3rd Mar., 1905—Accepted, 6th Apr., 1905

PROVISIONAL SPECIFICATION.

"Improvements in Mechanical-feed Lubricators".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, of the same place, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention has for its object to improve the construction and action of mechanical-feed lubricators so as to ensure a measured quantity of the lubricant used, being delivered at any desired interval, and to any desired part or parts of the machinery in connection with which the lubricator is used, the amount of lubricant supplied being proportionate to the speed of the machine, and also being capable of adjustment at will.

In carrying out the invention, according to one modification, there is provided an oil reservoir or tank, of a shape and size depending on the particular machine in connection with which the lubricator is to be used; and either open to the atmosphere, or if forced lubrication is desired, provision may be made for applying air pressure within the tank. The inside of the bottom of this tank is in the form of a circular disc, preferably raised slightly above the level of the surrounding part of the bottom of the tank. At a radius preferably of about three-quarters the radius of this fixed disc, holes are bored in the disc and in the bottom of the tank; in which holes are secured the ends of a corresponding number of oiling pipes leading to the various parts of the machine which it is desired to lubricate; the number of such holes and pipes depending on the number of parts which it is necessary to lubricate. A slot is cut in the disc midway between each of the holes and extends out to the edge of the disc, the inner edges of these slots being at the same radius from the centre of the disc as the inner edges of the holes. A central stud extends up into the tank, and on this stud there is a disc, the edge of which is formed with teeth so that it can be rotated either regularly or intermittently, by suitable gearing, from the machine to be lubricated One or more holes are formed in this rotating disc at the same radius as the holes in the fixed disc below, the thickness of the rotating disc, and the diameter of the hole or holes determining the quantity of lubricant delivered at each interval. On the upper side of the rotating disc is another disc prevented in any convenient manner from rotating, and held down preferably by a spring extending between its upper side and a nut adjustable on the central stud, the bearing surfaces of the three discs being machined to ensure oil tight contact between them. This upper fixed disc has holes bored through it vertically above both the radial slots, and also above the oil holes in the lower fixed disc; and stand pipes are inserted in the second-named holes in the upper fixed disc. These stand pipes extend up above the highest level of the oil in which the discs are always submerged, the interior of the pipes being thus open to the atmosphere or the air pressure within the tank.

When the rotating disc is turned the hole in it comes above one of the radial slots in the lower fixed disc, and underneath a hole in the upper fixed disc,

[Price 8d.]

PRICE 6d.

so that, if any air is imprisoned in the hole in the rotating disc, it can readily escape, as the hole communicates at this point with a free passage on both its top and bottom sides; and, in any case, the hole is at once filled with lubricant, which is not possible in lubricating mechanism, delivering a measured quantity of lubricant, hitherto in use, where no provision is made for first allowing the air to escape before taking in the lubricant. As the disc rotates a little further, the hole in it filled with lubricant comes over one of the lubricating holes in the lower fixed disc, and at the same time under one of the stand pipes in the upper fixed disc. The atmospheric pressure in the stand pipe will ensure that the measured quantity of lubricant leaves the hole in the rotating disc at this point, and passes into the respective oiling pipe; and if air pressure is used, it will also ensure that the lubricant is carried to its destination against back pressure.

It will be obvious that, as the amount of lubricant supplied each time is that represented by the contents of the hole in the rotating disc, an exact and similar quantity of oil is fed each time, and, as the speed of the disc depends approximately upon the speed of the machine from which it is driven, the amount of lubricant supplied will be proportionate to the speed of the machine. Further, if a variable speed arrangement such as a ratchet device which may move one or more teeth per stroke is used, the lubrication of the machine can be adjusted at will, with the assurance that it will continue to operate steadily and regularly as long as the machine is running.

Below the lubricator a sight feed glass may be arranged so that the drops may be seen falling into each oiling pipe in turn.

The arrangement described will feed equal quantities of oil to each of the oil pipes; but a variety of modifications can be readily designed to give any required quantity of lubricant at any one point to suit special circumstances. For example, if it is desired to give one or other pipe more oil, two or more of the holes in the lower fixed disc may be connected to the same oiling pipe, or these holes need not be all on the same circle but those requiring more oil may be placed in an outer circle, and those requiring less oil in an inner circle; while, in the rotating disc, one or more holes may be arranged at the outer radius, and only one be arranged at the inner radius to achieve the desired results.

In some cases the upper fixed disc may be dispenesd with; the stand pipes being supported in any convenient manner. Or instead of a rotating disc, a sliding bar having a measuring hole or holes through it may be used, this bar being moved backwards and forwards so that the hole or holes in it comes alternately over filling and discharging apertures in upper and lower fixed discs or plates.

Dated this Tenth day of June, 1904.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow.
Applicants Agents.

COMPLETE SPECIFICATION.

"Improvements in Mechanical-feed Lubricators".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention

and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement;—

This invention has for its object to improve the construction and action of mechanical-feed lubricators so as to ensure a measured quantity of the lubricant used being delivered at any desired interval, and to any desired part or parts of the machinery in connection with which the lubricator is used, the amount of lubricant supplied being proportionate to the speed of the machine, and also being capable of adjustment at will.

In order that the invention and the manner of performing the same may be properly understood, we hereunto append two sheets of explanatory drawings, throughout which like reference letters and numerals indicate similar parts; and in which Figure, 1, Sheet, 1, is a sectional elevation, and Figure, 2, a sectional plan of a mechanical-feed lubricator as made according to one example of our improvements, whilst Figures, 3 and 4, Sheet, 2, are, respectively, similar views showing a second example.

In carrying out the invention, according to the example shown in Figures, 1 and 2, of the drawings, there is provided an oil reservoir or tank, A, which is approximately circular in plan and communicates with the atmosphere by the opening, A^1; or the tank may be of any shape and size depending on the particular machine in connection with which the lubricator is to be used, and if forced lubrication is desired provision may be made for applying air pressure within the tank, A.

The inside of the bottom of this tank, A, is in the form of a circular disc, A^2, preferably raised slightly above the level of the surrounding part of the bottom of the tank. At a radius preferably of about three-quarters the radius of this fixed disc, apertures, B are bored in the disc and in the bottom of the tank, A; in which apertures are secured the ends of a corresponding number of oiling pipes, B^1, leading to the various parts of the machine which it is desired to lubricate; the number of such apertures, B, and pipes, B^1, depending on the number of parts which it is necessary to lubricate, five being shown in this example. A slot, C, is cut in the disc, A^2, midway between each of the apertures, B, and extends out to the edge of the disc, A^2, the inner edges of these slots, C, being at the same radius from the centre of the disc, A^2, as the inner edges of the apertures, B. A central stud, C^1, extends up into the tank and on this stud there is a disc, D, the edge of which is formed with teeth, D^1, so that it can be rotated either regularly or intermittently by a pinion, D^2, and shaft, D^3, driven by suitable gearing (not shown) from the machine to be lubricated. An aperture, D^4, is formed in this rotating disc, D, at the same radius as the apertures, B, in the fixed disc, A^2, below, or there may be more than one such hole, D^4, the thickness of the rotating disc and the diameter of the aperture or apertures determining the quantity of lubricant delivered at each interval. On the upper side of the rotating disc, D, is another disc, E, made with a projection, E^1, extending beneath a lug, A^3, formed on the inner side of the tank, A, so that a screwed pin, E^2, passing through a hole in the lug, A^3, and entering a hole in the projection, E^1, prevents the disc, E, from rotating. Or this disc may be prevented from rotating in any convenient manner, and it is held down preferably by a spring, G, extending between its upper side and a nut, G^1, adjustable on the central stud, G^1, the bearing surfaces of the three discs, A^2, D, E, being machined to ensure oil-tight contact between them. This upper fixed disc, E, has apertures, E^3, bored through it vertically above both the radial slots, C, and also apertures bored through it above the oil apertures, B, in the lower fixed disc, A^2; and stand pipes, G^2, are inserted in the apertures in the upper fixed disc, E. These stand pipes, G^2, extend up above the highest level of the oil in which the discs, A^2, D, E, are always submerged, the interior of the pipes being thus open to the atmosphere, or the air pressure within the tank, A.

When the rotating disc, D, is turned the aperture, D^4, in it comes above one of the radial slots, C, in the lower fixed disc, A^2, and underneath an aperture, E^3, in the upper fixed disc, so that, if any air is imprisoned in the aperture, D^4, in the rotating disc, D, it can readily escape, as the aperture communicates at this point, with a free passage on both its top and bottom sides, and, in any case, the aperture, D^4, is at once filled with lubricant, which is not possible in lubricating mechanism, delivering a measured quantity of lubricant, hitherto in use, where no provision is made for first allowing the air to escape before taking in the lubricant. As the disc, D, rotates a little further, the aperture, D^4, in it filled with lubricant comes over one of the lubricating apertures, B, in the lower fixed disc, A^2, and, at the same time, under one of the stand pipes, G^2, in the upper fixed disc, E. The atmospheric pressure in the stand pipe, G^2, will ensure that the measured quantity of lubricant leaves the aperture, D^4, in the rotating disc, D, at this point, and passes into the respective oiling pipe, B^1; and if air pressure is used, it will also ensure that the lubricant is carried to its destination against back pressure.

It will be obvious that, as the amount of lubricant supplied each time is that represented by the contents of the aperture, D^4, in the rotating disc, D, an exact and similar quantity of oil is fed each time, and, as the speed of the disc depends approximately upon the speed of the machine from which it is driven, the amount of lubricant supplied will be proportionate to the speed of the machine. Further, if a variable speed arrangement such as a ratchet device which may move one or more teeth per stroke is used, the lubrication of the machine can be adjusted at will, with the assurance that it will continue to operate steadily and regularly as long as the machine is running.

Below the lubricator a sight feed glass may be arranged so that the drops may be seen falling into each oiling pipe in turn.

The arrangement described will feed equal quantities of oil to each of the oil pipes, B^1; but a variety of modifications can be readily designed to give any required quantity of lubricant at any one point to suit special circumstances. For example, if it is desired to give one or other pipe, more oil, two or more of the apertures, B, in the lower fixed disc, A^2, may be connected to the same oiling pipe, or these holes need not be all on the same circle, but those requiring more oil may be placed in an outer circle, and those requiring less oil in an inner circle; while, in the rotating disc, D, one or more apertures, D^4, may be arranged at the outer radius, and only one be arranged at the inner radius to achieve the desired results.

In some cases, the upper fixed disc, E, may be dispensed with; the stand pipes, G^2, being supported in any convenient manner.

Instead of a rotating disc, D, the arrangement shown in Figures, 3 and 4, may be used. As shown in these figures the measuring apertures, D^2, of which three are shown, are formed in a bar, D, which is reciprocated by a crank shaft, H, and connecting rod, H^1, so that the apertures, D^4, in it come alternately between filling apertures, E^3, C, and discharging pipes, G^2, and apertures, B, in the upper and lower fixed discs or plates, E, A^2. The upper disc, E, is held in position by bolts, J, oil-tight contact between the surfaces being ensured by springs, G, and nuts, G^1, on the bolts, which also serve to guide the sliding bar, D.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1—In a mechanical-feed lubricator, a lubricant containing tank in which is a moving disc or bar having in it one or more apertures and working in conjunction with devices for filling and discharging such aperture, the devices

being such that any air in the aperture is first allowed to escape before the lubricant is taken in and that air pressure ensures the lubricant leaving the aperture, substantially as described.

—2—In a mechanical-feed lubricator, a lubricant containing tank in which is a moving disc or bar having in it one or more apertures and working in oil-tight contact with lower and upper fixed plates, the former having in it alternate lubricant filling and discharging apertures and the latter having in it alternate apertures and stand pipes over the discharge apertures and extending above the level of the lubricant, the parts being combined, arranged, and operating, substantially as described.

—3—In a mechanical-feed lubricator, a lubricant containing tank in which is a moving disc or bar having in it one or more apertures and working in oil-tight contact with a lower fixed surface in which are alternate lubricant filling and lubricant discharging apertures and stand pipes over the latter and extending above the level of the lubricant, the parts being combined, arranged, and operating, substantially as described.

Dated this First day of March, 1905.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow.
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1905.

A.D. 1904. JUNE 11. N° 13,210.
ALBION MOTOR CAR CO. [LTD.] & *another's* COMPLETE SPECIFICATION.

FIG. 1.

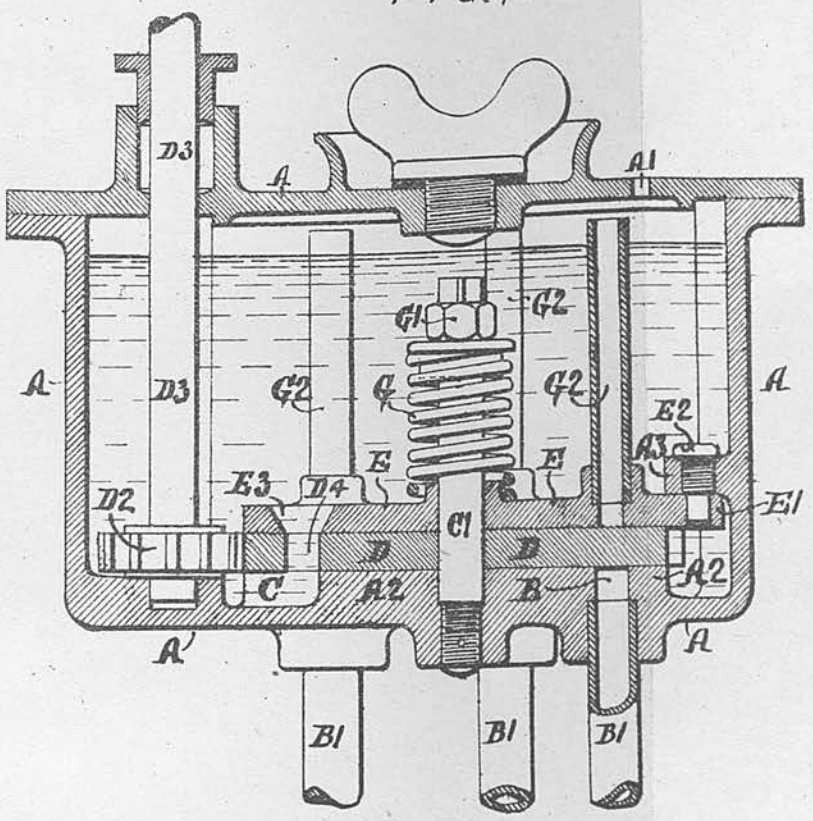


FIG. 2.

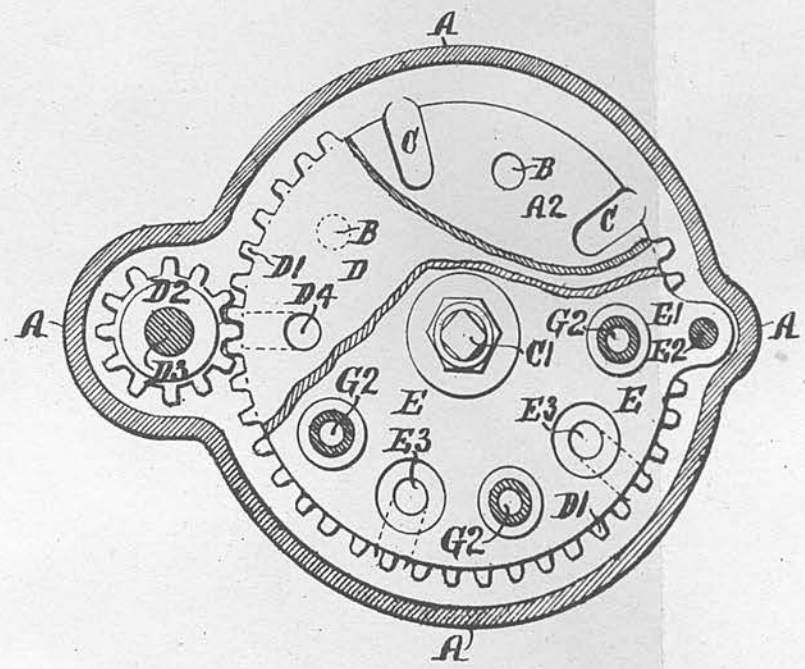


FIG. 3.

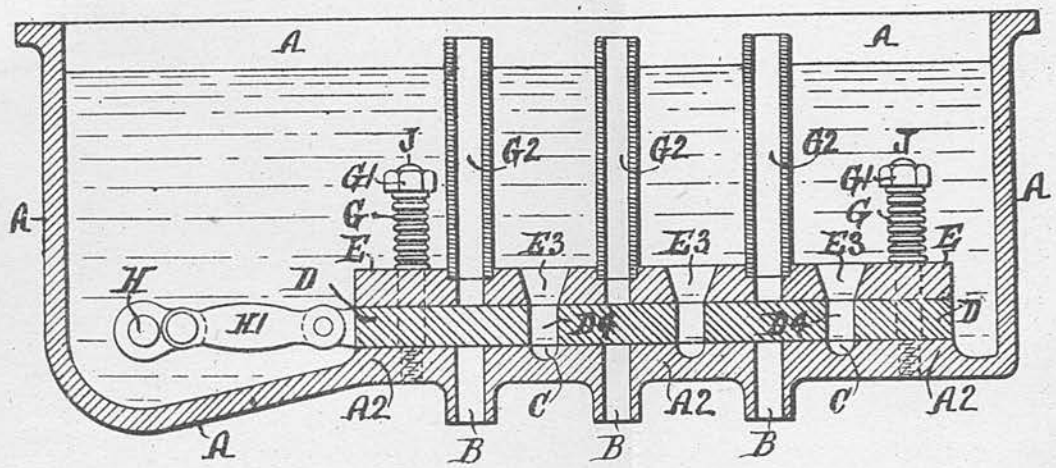
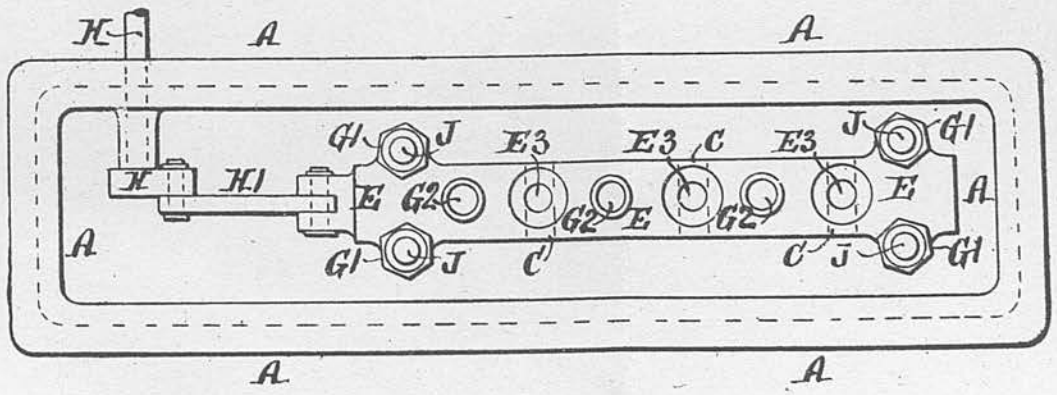


FIG. 4.



Malby&Sons, Photo-Litho.

[Second Edition.]

16.

N° 7078 A.D. 1905

Date of Application, 4th Apr., 1905—Accepted, 8th June, 1905

COMPLETE SPECIFICATION.

"Improvements in Mechanical-feed Lubricators".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention has for its object to improve the construction and action of mechanical-feed-lubricators so as to ensure a measured quantity of the lubricant used being delivered, under pressure, at any desired interval and to any desired part or parts of the machinery in connection with which the lubricator is used, the amount of lubricant supplied being proportionate to the speed of the machine, and also being capable of adjustment at will.

In carrying out the invention there is provided an oil container of a shape and size depending on the particular machine in connection with which the lubricator is to be used. On the bottom of this container there is a disc (or it might be a cylinder) having in it ports equidistant from its centre and communicating alternately with the interior of the container and with pipes leading to the various parts of the machine which it is desired to lubricate. A second disc (or it might be a cylinder) which is rotated in any desired manner, either continuously or intermittently, works in oil tight contact over the bottom disc (or cylinder) and carries a pump cylinder fitted with a plunger. A port in the cylinder works over the ports in the bottom disc, and the plunger is so actuated on the rotation of the disc that the lubricant is alternately drawn into the cylinder from the container and discharged from the cylinder into the lubricant pipes.

The construction of the improved form of lubricator may be largely varied without departing from the essence of the invention, but in order that the invention and the manner of performing the same may be properly understood, we hereunto append two sheets of explanatory drawings, throughout which like reference letters and numerals indicate similar parts; and in which Figures, 1 and 2, Sheet, 1, are, respectively, a sectional plan and a longitudinal vertical section of a mechanical-feed lubricator as made according to one example of our improvements; whilst Figures, 3 and 4, Sheet, 2, are, respectively, a plan and a transverse section of parts sufficient to show a second example; and Figures, 5 and 6, are similar views showing a third example.

As shown in Figures, 1 and 2, the improved lubricator consists of a rectangular box, A, which serves as an oil container, the box being filled through an opening in the cover plate, A^1, which opening is closed by a screwed plug, A^2. A central stud, B, extends up into the container, A, and on this stud there is a disc, B^1, machined on its upper surface and fixed clear of the bottom of the container, A, by studs, B^2, on its under side resting in depressions in the bottom of the container, so that the lubricant in the container has access to the space beneath this disc, B^1. (If preferred the disc, B^1, may be cast in a piece with the container, A). The centre of the studs, B^2, is preferably at a radius of about $^3/_4$ the radius of the disc, B^1, and ports, B^3, are formed through the disc and studs, and also through nipples, A^3, on the bottom of the con-

[Price 8d.]

PRICE 6d.

tainer, A, to which nipples may be secured the ends of a corresponding number of oiling pipes (not shown) leading to the various parts of the machine which it is desired to lubricate, the number of such ports and pipes depending on the number of parts which it is necessary to lubricate, five ports being shown in this example. Midway between each of these ports, B^3, a corresponding number of other ports, B^4, give communication between the upper and under side of the disc, B^1. On the stud, B, there is a second disc, C, machined on its under surface so that it makes oil tight contact with the under disc, B^1, and covers the ports, B^3, B^4, the two discs being kept in close contact by a spring, C^1, extending between a thrust washer, C^2, on the stud, B, and the upper surface of the disc, C. Ratchet teeth, C^3, are formed on the edge of the disc, C, so that it may be rotated either continuously or intermittently by a spring-controlled pawl, D, engaging with the teeth and operated by a rod, D^1, reciprocated by suitable gearing (not shown) from the machine to be lubricated.

A pump cylinder, E, is formed on, or might be fixed to, the upper surface of the disc, C, the axis of the cylinder being parallel to the stud, B, and the position of the cylinder being such that a port in its lower end is in the same radius as the ports, B^3, B^4. The cylinder, E, is fitted with a plunger, E^1, which tends to rise under the influence of a spring, E^2, on the cylinder bearing on a collar, E^3, on the plunger, so that a roller, E^4, on the upper end of the plunger is kept in contact with a cam track, F, F^1, F^2, on the under side of the cover, A^1, this track being in a circle corresponding to the circle of the ports, B^3, B^4, the axis of the roller, E^4, being always kept radial to the centre of the disc by an arm, E^5, extending from the plunger, E^1, to the central stud, B, which projects through an opening formed for it in the arm.

With the parts in the position shown in the drawings the plunger, E^1, is at the bottom of its stroke, but when the disc, C, is rotated as hereinbefore described the roller, E^4, being constrained by the spring, E^2, to follow the profile of the cam, rises up the inclined portion, F, and the plunger, E^1, also rises in the cylinder, E. As, when this action is taking place, the port in the cylinder is then open to a charging port a charge of lubricant is drawn in. When the plunger reaches the top of its stroke the roller, E^4, then bears on the upper flat portion, F^1, of the cam; and though the pump continues to rotate there is no further movement of the plunger, owing to the shape of this part of the cam, until the pump begins to come over the next discharging port, B^3. When the pump reaches this position the roller, E^4, begins to ride down the next inclined portion, F, of the cam forcing the plunger, E^1, down against the action of its spring, E^2, and the contents of the cylinder, E, are discharged through that port, B^3. A suitable flat part, F^3, in the cam track is provided so that there may be no relative motion of the plunger, while the pump is travelling from a discharge port, B^3, to the next charging port, B^4, on reaching which the action of the parts is repeated as hereinbefore described.

In order to prevent the reaction of the roller, E^4, on the inclined portions, F, of the cam track, rotating the disc, C, backwards on the back stroke of the rod, D^1, a second spring-controlled pawl, D^2, is provided to engage with the ratchet teeth, C^3, on the edge of the disc, C. This pawl, D^2, may be fixed, but it is preferably carried on a handled rod, D^3, projecting through the side of the container, A, so that the disc, C, may be given a few turns by hand and thus give a feed of oil to the machine before starting to work.

The upper flat portions, F^1, of the cam track are carried each on the lower end of a screwed spindle so that the position of these parts and, consequently, the height to which the plunger can rise is adjustable. The amount of lubricant fed by the pump at each stroke may thus be varied at will. The other portions of the cam track are preferably of a fixed height relative to the stroke of the plunger, so that this plunger is forced to the bottom of the cylinder at each stroke and the possibility of air-lock in the pump is eliminated.

Instead of the pump cylinder, E, being arranged vertically on the rotating

disc, C, it may be arranged horizontally and either as shown in Figures, 3 and 4, radiating outwards from the disc, or as shown in Figures, 5 and 6, extending diametrically across the disc to economise space. The cam track, F, F^1, F^2, (shown by a dotted line only) is arranged circularly in both these modifications instead of horizontally as in the modification first hereinbefore described, but the action of the parts is substantially similar and therefore need not be further described.

It is obvious that instead of superposed discs, one of which carries the pump, being used, the pump may be carried on a cylindrically or conically surfaced part working either within or upon a counterpart stationary cylinder or cone, and that a plurality of pumps on one disc or cylindrically or conically surfaced part may be used.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1—In a mechanical-feed lubricator, a reciprocating pump rotated successively over charging and discharging ports and operated so as to draw in and deliver lubricant through the ports, as described.

—2—In a mechanical-feed lubricator, a lubricant container in which is a fixed disc having in it charging and discharging ports communicating respectively with the container and with discharge pipes, and a rotating disc carrying a reciprocating pump and working over the charging and discharging ports, as described.

—3—In a mechanical-feed lubricator, a lubricant container in which is a fixed disc having in it charging and discharging ports communicating respectively with the container and with discharge pipes, and a rotating disc carrying a reciprocating pump and working over the charging and discharging ports, the pump plunger being actuated by a spring and cam track, as described.

Dated this Third day of April, 1905.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[G. 9709—50—1/1907.]

[This Drawing is a reproduction of the Original on a reduced scale.]

(2nd Edition) SHEET 1.

FIG. 1.

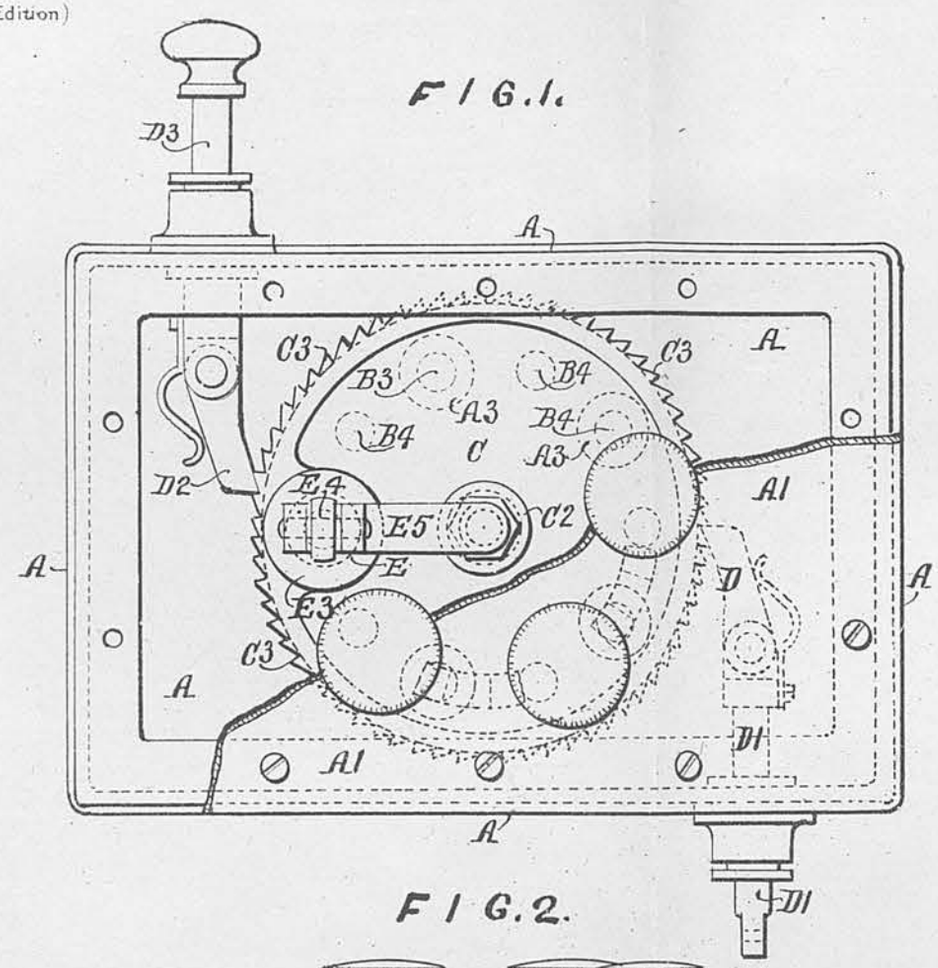
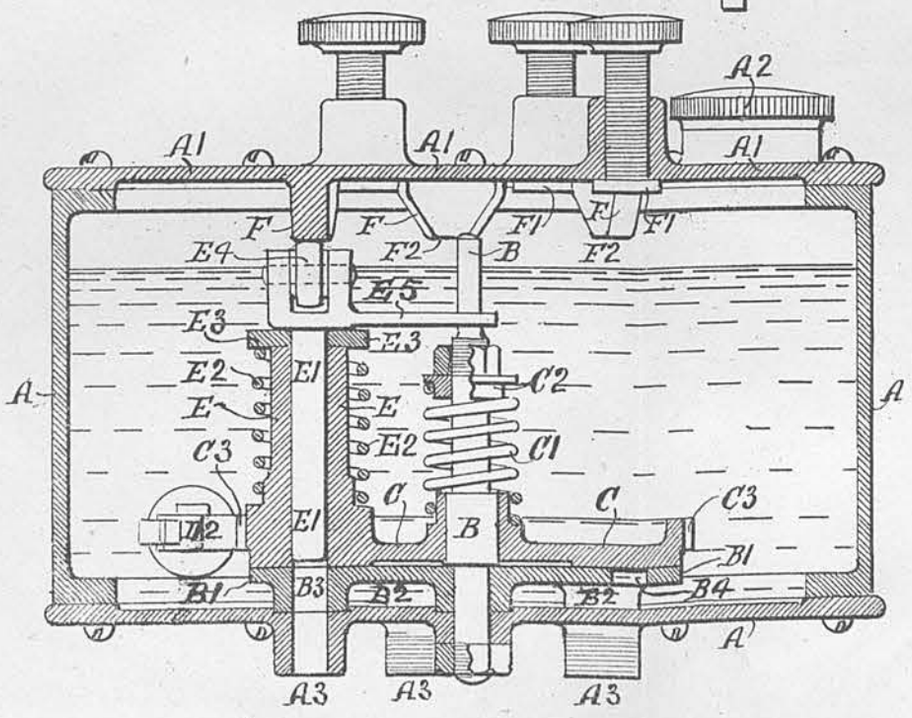


FIG. 2.



SHEET 2.

FIG. 3.

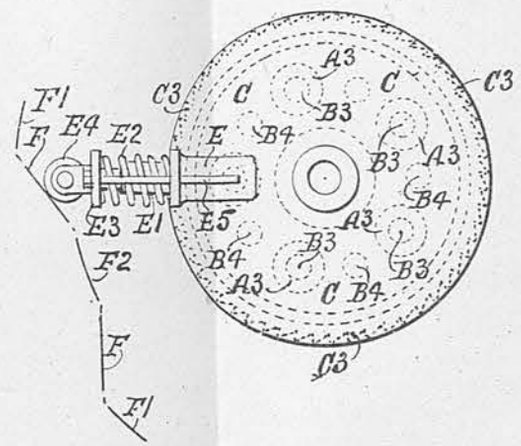


FIG. 4.

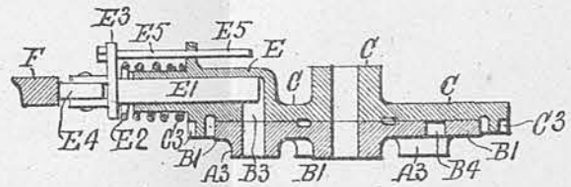


FIG. 5.

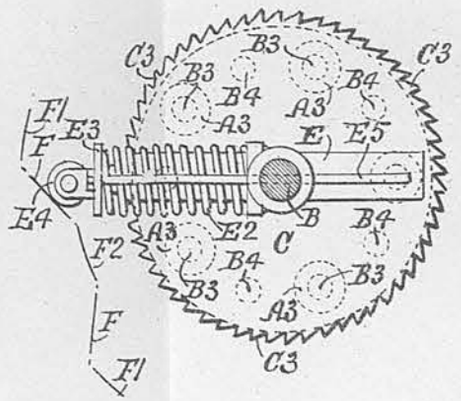
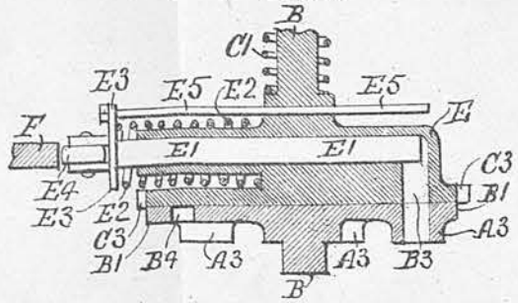


FIG. 6.



Malby & Sons, Photo-Litho.

17

N° 23,469 A.D. 1905

Date of Application, 15th Nov., 1905

Complete Specification Left, 14th May, 1906—Accepted, 16th Aug., 1906

PROVISIONAL SPECIFICATION.

"A New or Improved Flexible Coupling".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Lanark, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention has for its object to provide a flexible coupling more particularly adapted for use in connection with motor vehicles and which while very compact is simple, effective and not readily damageable.

In carrying out the invention there is provided loose upon the driven shaft a sleeve operatively connected to the driving shaft and carrying at its end remote from this connection one member of a jaw clutch. The other member of this jaw clutch is formed upon a sleeve keyed to the driven shaft.

The two clutch members are always in engagement but their counterpart members are so formed that they permit of a dennite relative rotation of the two parts. Within this amount of rotation a spring acts in a manner hereinafter described. That is to say, under excessive torque or if the spring break, the counterpart members of the clutch enter into driving engagement; they may or may not—it is not of moment—encounter each other when the spring is entirely freed.

The spring referred to is of helical form and preferably of rectangular section. It is of a diameter to closely encircle the loose and part of the fixed sleeve and is arranged concentrically to those sleeves. One end of it is anchored to the loose and one end to the fixed sleeve and preferably its hand-of-coil is such that its coils are contracted by the driving torque. The anchoring devices consist of jaws formed upon the sleeves and between which the ends of the spring, bent in a direction parallel to its axis, are entered. They may be secured in position in the jaws by pins passed through them and the jaws or by other convenient devices. Projections of a weight and radial distance to balance the jaws and spring ends are preferably formed upon the sleeves at points diametrically opposite these parts.

Those parts of the sleeves which are embraced by the ends of the spring are of a diameter to closely fit within the spring while those parts (it may be only that of the loose sleeve) which are about the centre of its length are of a lesser diameter so leaving a clearance between them and the spring even when the latter is most closely coiled.

The effect of the closely fitting parts of the sleeves is that upon the spring being subjected to torque and becoming reduced in diameter its ends engage the closely fitting parts somewhat after the manner of a coil clutch and thus take a proportion of the driving effort so relieving the anchors.

Dated this Fourteenth day of November, 1905.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

[Price 8d.]

PRICE 6d.

COMPLETE SPECIFICATION.

"A New or Improved Flexible Coupling".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Lanark, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention has for its object to provide a flexible coupling more particularly adapted for use in connection with motor vehicles and which while very compact is simple, effective and not readily damageable.

According to the invention there is provided loose upon the driven shaft a sleeve operatively connected to the driving shaft and carrying at its end remote from this connection one member of a jaw clutch. The other member of this jaw clutch is formed upon a sleeve keyed to the driven shaft.

The two clutch members are always in engagement but their counterpart members are so formed that they permit of a definite relative rotation of the two parts. Within this amount of rotation a spring acts in a manner hereinafter described. That is to say, under excessive torque or if the spring break, the counterpart members of the clutch enter into driving engagement; they may or may not—it is not of moment—encounter each other when the spring is entirely freed. Further, the spring is preferably of such a diameter and of such hand-of-coil that in operation it is contracted upon the clutch members by the driving torque and so acts after the manner of a coil clutch.

In order that the invention and the manner of performing the same may be properly understood, there is hereunto appended a sheet of explanatory drawings, throughout which like reference letters indicate like parts, showing in Figure, 1, in sectional side elevation and in Figure, 2, in transverse vertical section upon the line *a*—*a* in Figure, 1, one example of the improved coupling; and in Figures, 3, and 4, like views of another example variant in detail.

In the example shown in Figures, 1, and 2, there is provided loose upon the driven shaft, A, a sleeve, B, operatively connected by a universal coupling, C, to the driving shaft, D, and carrying at its end remote from this coupling one member, E, of a jaw clutch. The other member, G, of this jaw clutch is formed upon a sleeve, H, keyed to the driven shaft, A.

The clutch members, E, G, are always in engagement but their jaws—as will be seen in Figure, 2,—permit of a small definite relative rotation of the two parts. Within this amount of rotation the spring, J, acts in the manner described, and in this particular instance the jaws, E, G, of the clutch have such clearance as not to encounter each other when the spring is free, so that the spring acts to some extent as a cushion even if the direction of drive is reversed.

The spring, J, is of helical form and rectangular section in the present example. It is of a diameter to closely encircle part of the loose sleeve, B, and part of the fixed sleeve, H,—the sleeves may however, be so formed that the spring closely embraces more of the sleeve if it be found desirable. The ends of the spring, J, are bent into a direction parallel to its axis and entered between jaws, K, formed upon the sleeves, B, H, so as to anchor the spring firmly, pins, I, being passed through jaws and spring to prevent the displacement of the latter. Projections, M, of a weight and radial distance to balance the jaws, K, and spring ends are formed upon the sleeves, B, H, at points diametrically opposite these parts.

Those parts of the sleeves, B, H, which are embraced by the ends of the spring, J, are of a diameter to closely fit within the spring which is preferably

ground internally for this purpose, while those parts of the sleeves which are at about the centre of its length are of lesser diameter so leaving a clearance between them and the spring even when the latter is most closely coiled.

The effect of the closely fitting parts of the sleeves, B, H, is, that, upon the spring, J, being subjected to torque and becoming reduced in diameter, its ends engage the closely fitting parts of the sleeves after the manner of a coil clutch and thus take a proportion of the driving effort, so relieving the anchors.

The example shown in Figures, 3, and 4, only differs in regard to proportions—the length of the parts and the weight of the spring—and in regard to the method of anchoring the spring. In this case, instead of the ends of the spring, J, being bent parallel with its axis, they are left helical and are secured in place upon the sleeves, B, H, by set pins, K, passed through them and into the sleeves; keys, L, being inserted in seats in spring and sleeves parallel with their axis to further secure them. In order to counterbalance the weights of the ends of the spring, J, and of the set pins, K, and at the same time to hold the springs in position so as to prevent it working outwardly over the sleeves or over expanding upon release, blocks, M, having projecting lips engaging the edges of the spring are secured to the sleeves, B, H, by set pins, N.

It is to be understood that the carrying out of the invention is capable of considerable variation for example, in regard to the form of clutch jaws, the form of spring, the method of anchoring it, and whether or not it is arranged to closely embrace the sleeves.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed we declare that what we claim is:—

—1— A flexible coupling comprising two sleeves, one loose, the other fixed upon a shaft, and having counterpart clutch parts constructed to permit of limited relative movement, and a helical spring encircling the sleeves and fixed at opposite ends to them.

—2— A flexible coupling comprising two sleeves, one loose, the other fixed upon a shaft, and having counterpart clutch parts constructed to permit of limited relative movement, and a helical spring encircling and fixed to the sleeves and so closely embracing them or part of them that it acts as a coil clutch upon them.

—3— In the flexible coupling claimed in the foregoing claims hereof, weights disposed upon the sleeves diametrically opposite the ends of the springs and the devices securing them, and of such proportions and radial distance as to counterbalance the said parts.

—4— In the flexible couplings claimed in Claims, 1, and 2, hereof, an anchoring device for the springs consisting of a pair of jaws formed on the sleeve, and between which the bent end of the spring fits and is secured.

Dated this Twelfth day of May, 1906.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1906.

FIG. 1.

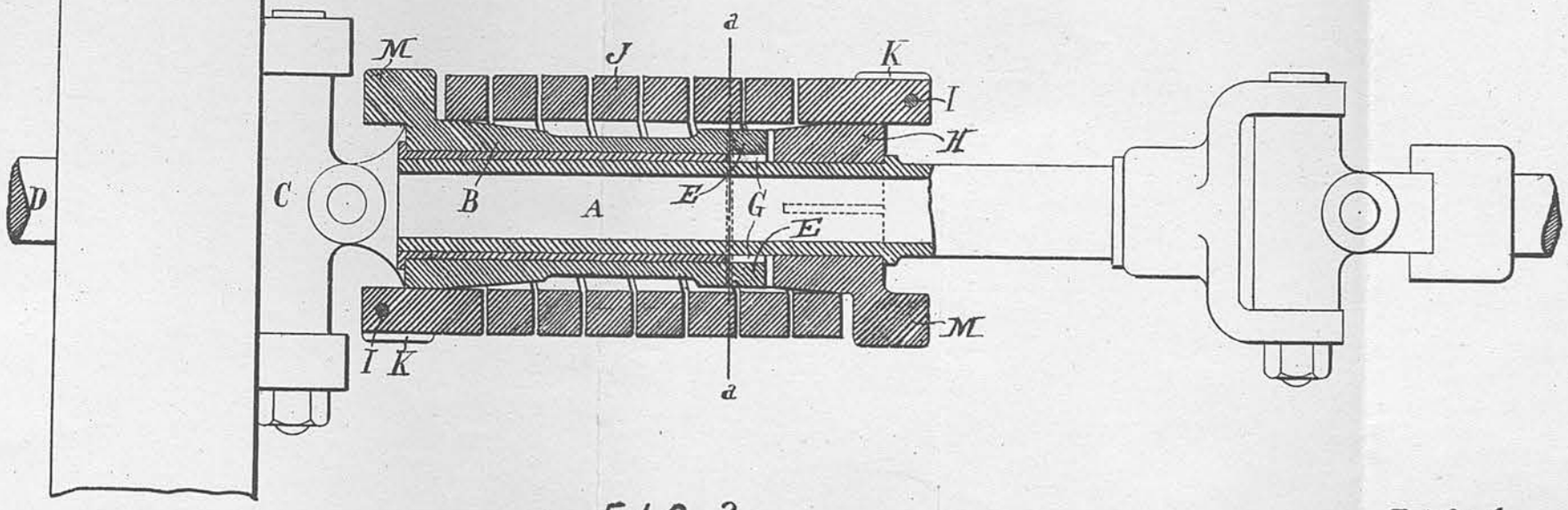


FIG. 2.

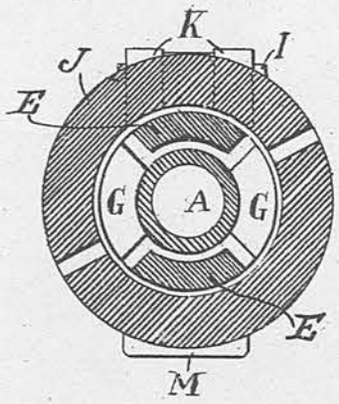


FIG. 3.

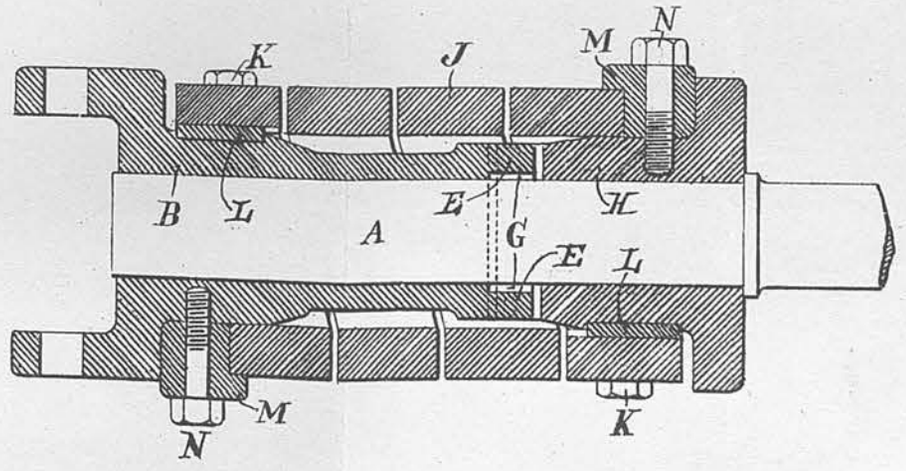
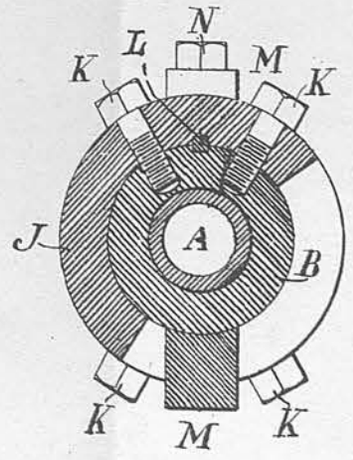


FIG. 4.



Malby & Sons, Photo-Litho.

18.

N° 26,560 A.D. 1905

Date of Application, 20th Dec., 1905—Accepted, 7th June, 1906

COMPLETE SPECIFICATION.

"Improvements in Friction Clutches".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Lanark, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention relates to clutches of the "Weston" type in which are series of discs, alternate ones of which are carried by the driving and by the driven members of the clutch; the friction between the discs (of which there are three or more in each series) when they are pressed together transmitting the drive from the driving to the driven member. In order to free the discs definitely from each other when the clutch is released, springs acting between one or other or both series of discs with or without conjoint action of the weights of the discs have been proposed or used, but it is obvious that such an arrangement is ineffective in a measure in that supposing the springs be arranged between the driven member discs although they separate those discs definitely from each other it is clear that they do not necessarily or definitely separate each driven disc from each of the two driving discs between which it works, but only from one of those discs. Nor, when there are springs upon each series of discs do they more than separate the discs of each series from those of the same series. They do not separate definitely a disc of one series from the adjacent discs of the other series. This invention has for its object to provide simple and effective means for equally separating all the discs from each other, that is to say, means such that, when the clutch is released, driving and driven discs move from each other as though they were connected by what is known as a "lazy tongs" linkage.

In order that the invention and the manner of performing the same may be properly understood there are hereunto appended three sheets of explanatory drawings throughout which like reference letters and numerals indicate like parts, and in which Figures, 1 and 2, Sheet, 1, and Figure, 3, Sheet, 2, are respectively a sectional end elevation, a longitudinal vertical section and a sectional side elevation of a clutch of the type described of more or less known form and having applied to it the improved disc-releasing devices, while Figures 4, 5, 6, 7, and 8, Sheet, 3, are detail views of these devices.

The clutch shown in Figures, 1, 2, and 3, of the drawings comprises a drum-like driving member, A, carrying on feathers, A^1, a series of annular driving discs, A^2. The driven member consists of a casing, B, running loosely on a sleeve-like part, A^3, formed on the driving member and carrying a series of annular driven discs, B^2, engaging bolts, B^1, passing through the casing, B, in such a manner as to transmit the drive to that casing. The driven discs, B^2, alternate with the driving discs, A^2, in known manner and behind the last disc, B^2, there is arranged a transmitting disc, B^3, also engaging the bolts, B^1, and transmitting the drive to the driven shaft, B^4. The clutch is normally kept in engagement by springs (which are not shown) arranged between the

[*Price 8d.*]

transmitting disc, B^3, and the adjacent end of the casing, B, and it is disengaged by moving the casing (to the right in Figures 2 and 3) on the sleeve, A^3, by means of a muff, B^5, on the driven shaft, B^4, and which has formed on it a flange, B^6, adapted to press upon the casing, and which may be bolted thereto, a check flange being, if necessary, provided for centering.

It is clear that there is no essential novelty in the form of clutch just described. It is only shown and described to illustrate the application of the improved devices and it is to be understood that the application of these devices is not in any way limited to a clutch of this precise construction, as it is clear that they are applicable to practically any form of clutch of "Weston" or modified "Weston" type.

The improved spring-actuated disc-separating devices are shown separately and to an enlarged scale in Figures, 4, 5, and 6. They are shown in position in the clutch in the preceding figure. They consist of rectangular blocks, C, built up of two parts embracing between them a pair of blade springs, C^1; the parts being secured together by rivets, C^2. These blocks are carried in counterpart apertures in the peripheries of the driven discs, B^2, that is to say, each block engages at its one side, one disc, B^2, and at its other side the next adjacent disc, B^2. The blocks are arranged in sets of three at 120 degrees to each other between each pair of discs, B^2, the left hand sides of three of the blocks engaging a particular disc while the right hand sides engage the next disc to the right, while the right hand sides of the three other blocks engage the same disc, the left hand sides engaging the next disc, B^2, to the left. This is clearly shown in Figure, 1, in which it will be seen that two of the pairs of springs, C^1, attached to the blocks are shown behind the top disc seen in that view and two in front.

As will be seen in Figures, 2 and 3, the springs C^1, are so set as to tend to press adjacent discs B^2, apart and they are compressed together so as to allow the driving discs A^2, and the driven discs, B^2, to come into frictional contact when end pressure is applied.

The inner edges of the blocks, C, engage the peripheries of the driving discs, A^2, and as shown in Figures, 5 and 6, the adjoining faces of the two parts of each block are so recessed and are kept at such a distance apart by the thickness of the springs, C^1, that an easy fit of the blocks upon the peripheries of the discs, A^2, is assured.

In Figures, 5 and 6, a block is shown in place between two of the discs, B^2, and with its inner edge engaging the periphery of one of the discs, A^2. In Figure, 5, the parts are shown as compressed together for engagement. In Figure, 6, they are shown as released, the springs, C^1, in this case pressing back each of the discs, B^2, an equal extent from the disc, A^2, which is maintained in its central position by its engaging with the slot formed between the two parts of the block, C.

The effect is, of course, exactly the same between either of the discs, B^2, shown in Figures 5 and 6, and the next adjacent disc, B^2, and thus, when the clutch is released, all the discs, B^2, move apart at the same time holding the discs, A^2, equidistantly between them in the manner described so entirely freeing the driving and driven discs from each other and ensuring free and practically frictionless running of the clutch when it is released.

It will be seen that the blocks, C, and springs C^1, tend to move outwards under the influence of centrifugal force when the clutch is running. A simple way of holding them in place is shown in Figure, 1, pins, D, being fixed in the ends of the springs and adapted to engage slots, D^1, cut in the discs, B^2, so as, while allowing of the flexure of the springs, to prevent their centrifugal movement. Any other convenient means to the same end may, however, be employed.

When the clutch is used for comparatively high speeds advantage may be taken of the pressure developed in the lubricant in the clutch casing by centri-

fugal force to assist in separating the two series of discs equally from each other.

Devices to this end are shown in Figures, 7 and 8; according to the example shown in Figure, 7, grooves, E, are cut partly across the faces of each of the driving discs, A^2. Lubricant flows into these grooves and as it cannot pass out at the outer ends as the grooves do not pass entirely across the discs, pressure is developed centrifugally and tends to separate the discs. Or, as in the example shown in Figure, 8, holes, G, may be pierced in the discs, short inwardly extending radial slots, G^1, being provided to allow of access of the lubricant to the holes. This arrangement acts in a like manner to that just described, excepting that it has not the effect of keeping the discs, A^2, centrally between adjacent pairs of discs, B^2. It is therefore and to that extent not so effective.

It is clear that the precise construction of the blocks and springs may be very considerably varied without departing from the essence of the invention which is the provision of a device engaging discs of one series so as to rotate with that series and freely engaging a disc of the other series so as while allowing of its relative rotation to control its endwise movements and springs for separating the discs with which it rotates equally in opposite directions from its centre, that is, from the point at which it engages the disc of the other series.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1—In a disc clutch in which a series of discs is connected to the driving and a series to the driven members, discs of the two series alternating with one another, means loosely connected to discs of one series for moving adjacent discs of the other series equidistantly from the intermediate disc of the first series.

—2—In a disc clutch devices for separating the discs of one member from the discs of another member consisting each of a part carried by adjacent discs of one member and engaging loosely the intermediate disc of the other member and springs carried on the part and so arranged as to tend to move the two discs equally in opposite directions from the intermediate disc, as described.

—3—In a disc clutch a block made in two parts adapted to engage and be held in recesses in two adjacent discs of one member of the clutch and carrying a pair of blade springs between its parts back to back and adapted to press upon the adjacent faces of the two discs and a recess in the block engaged by the edge of the disc of the other member intermediate to the two block-carrying discs.

—4—In combination with the devices which form the subject matter of the foregoing claims hereof, a device for assisting the separation of discs of each series consisting of apertures or grooves formed on or in the faces of one series of the discs in such a position and of such a shape that lubricant may enter them at their inner ends but is prevented from escaping at their outer ends which are also covered by the discs of the opposed series of discs.

Dated this Nineteenth day of December, 1905.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow.
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1906.

FIG. 1.

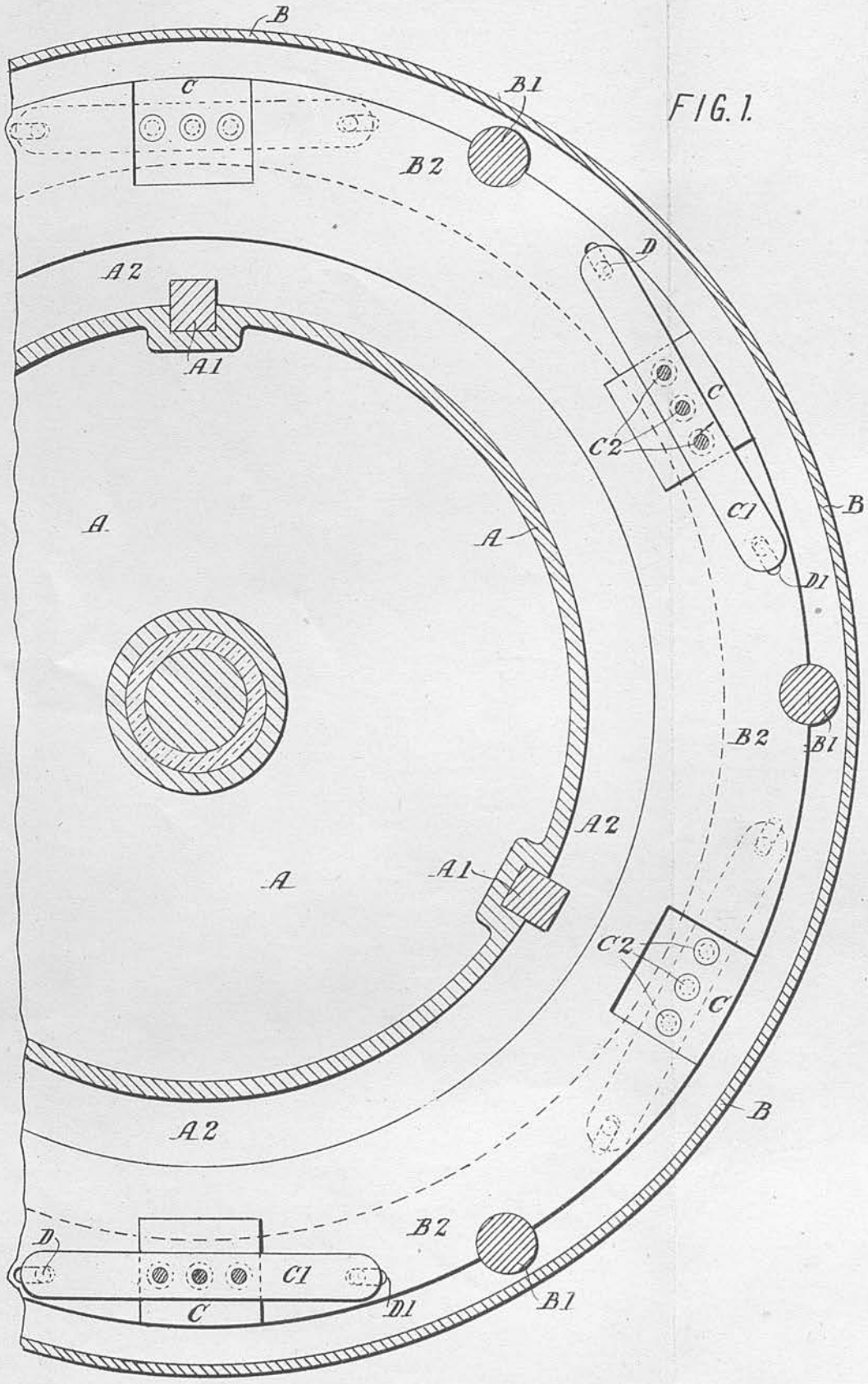
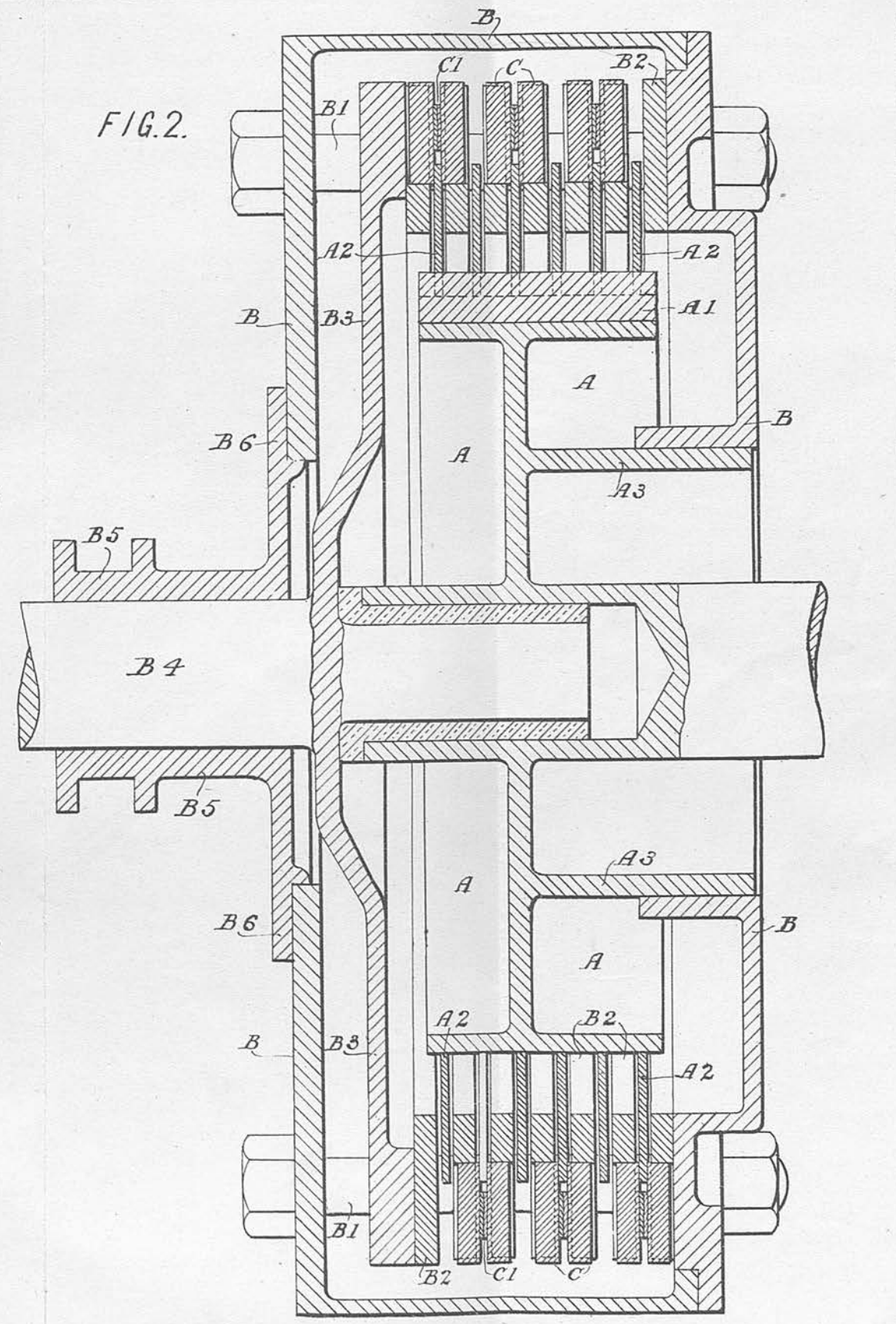


FIG. 2.



Malby&Sons, Photo-Litho.

FIG. 3.

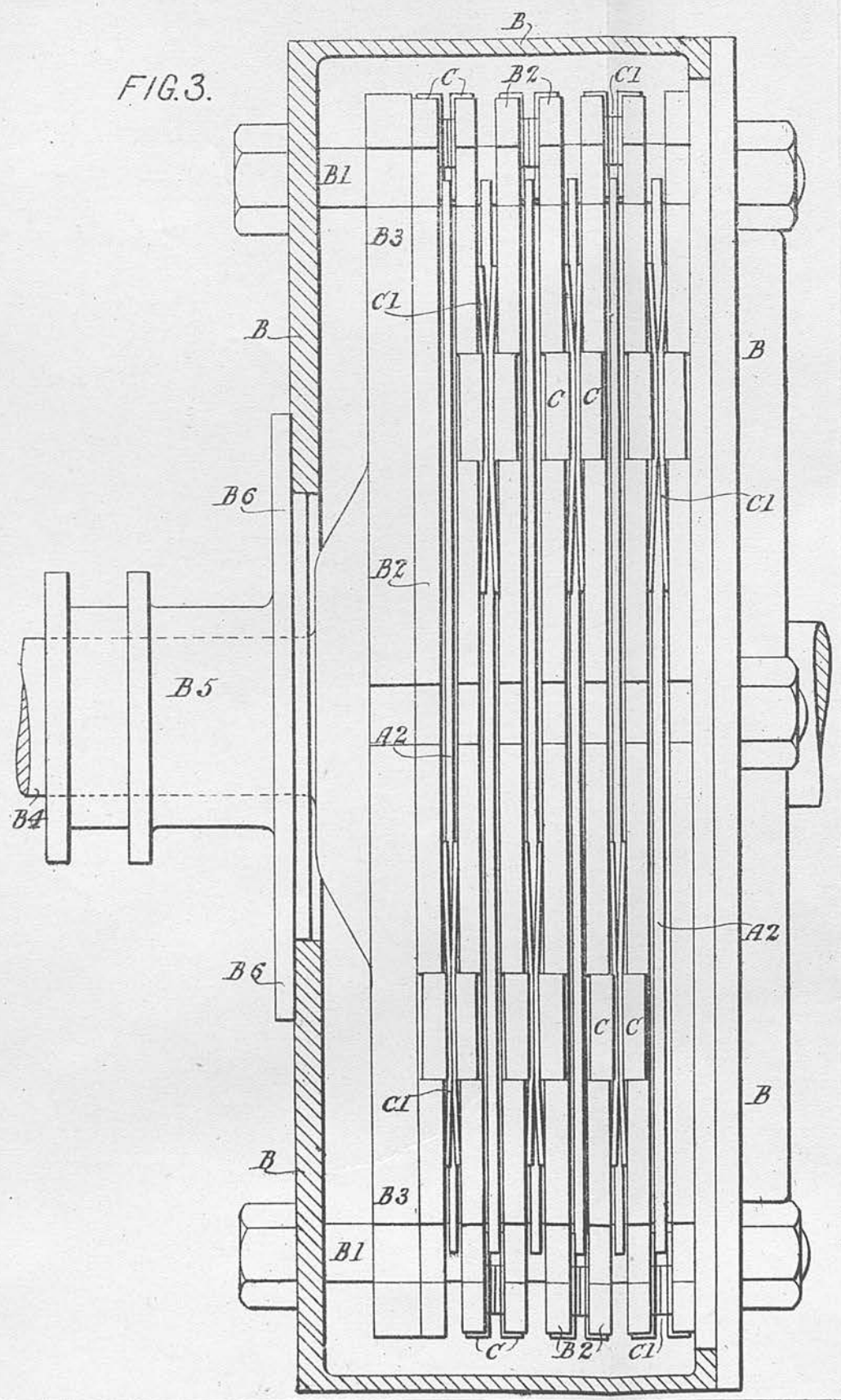


FIG. 4.

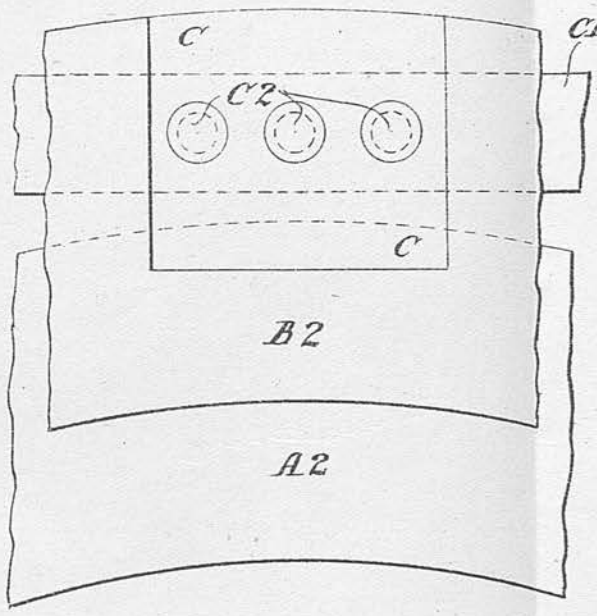


FIG. 5.

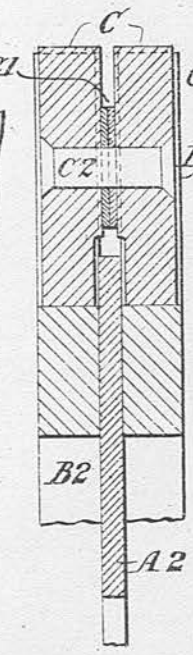


FIG. 6.

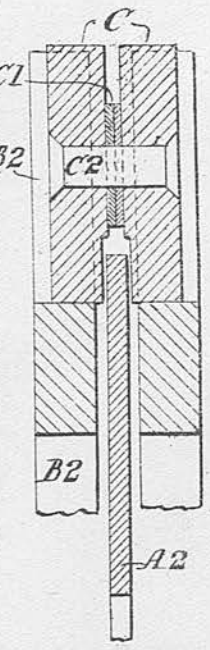


FIG. 7.

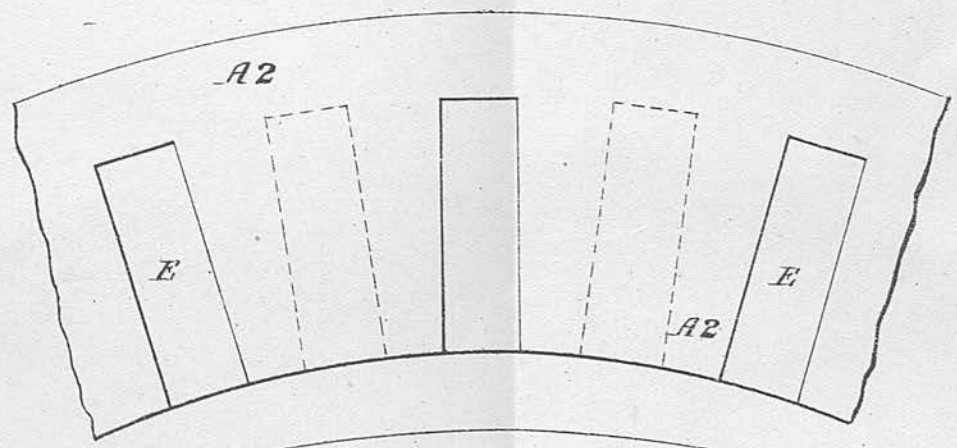
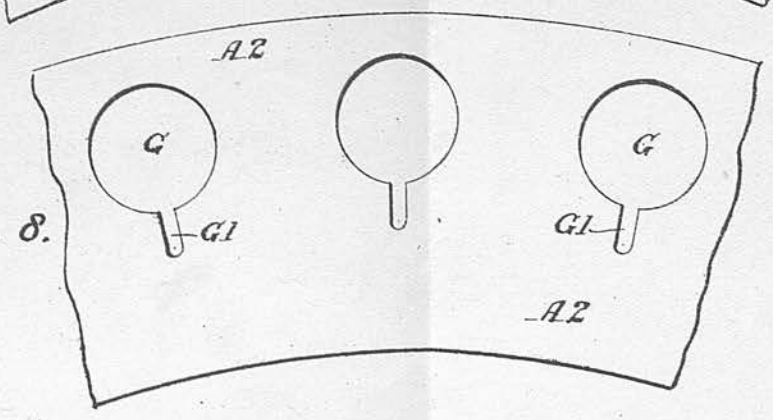


FIG. 8.



[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

19.

N° 7848 A.D. 1906

Date of Application, 2nd Apr., 1906
Complete Specification Left, 29th Sept., 1906—Accepted, 3rd Jan., 1907

PROVISIONAL SPECIFICATION.

"Improvements in Friction Clutches".

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Lanark, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to clutches of the "Weston" type, in which are series of discs, alternate ones carried by driving and driven members of the clutch and in which friction between the discs when they are pressed together transmits the drive. In order to more or less definitely free the discs from each other when the clutch is released, springs acting between adjacent discs of one or of each series have been proposed or used, but it is obvious that such an arrangement is ineffective in a measure in that, these springs only separate discs of the one series from adjacent ones of the same series, and even although the springs be applied to both series there is nothing to separate the discs of one series from those of the other series; that is to say, although the springs in both series even operate perfectly the adjacent discs of opposite series are still free to adhere to one another on one of their faces.

This defect has been overcome by having upon each disc of one series a rider or equivalent device carrying springs pressing against the adjacent discs of the other series on each side of that one. The same effect may be arrived at effectively in a more simple manner and that is the object of the present invention.

According to the present invention there is cut in each face of each disc of one series (it will be seen that it is unnecessary that the device should be applied to both series of discs) a number of recesses. The recesses are preferably radial and alternate on opposite sides of the discs in order that they may be of sufficient depth for their purposes without, on the one hand, unduly weakening the disc or, on the other hand, requiring that it be of excessive thickness. The recesses, however, may be arranged tangentially or in other convenient manner instead of radially.

Within each recess a spring is fixed so that its free end or ends bears upon the adjacent disc of the other series. Means are preferably provided for limiting the outward movement of the free ends of the springs, so that they cannot at any time project more than a very small amount beyond the surface of the disc. Where the recesses are radial and extend to the edge of the disc the stops may very conveniently be formed by bending over the free ends of the springs so that they engage with the other surface of the disc, or with a recess cut in the edge of the disc.

In operation, the springs carried in the recessed discs simply bear upon the surfaces of the adjacent discs (the springs being made, of course, of a material sufficiently hard to resist the wear thus imposed upon them). They free the discs equally when the clutch is released and when it is being put into gear they cause very gradual engagement—how gradual depending upon whether their ends be left free or, if stops be applied to them, the residual flexure remaining in the springs when they engage the stops.

[*Price 8d.*]

It is very evident that the forms of springs used may be widely varied and that the recesses may be arranged in many different ways.

Dated this Thirty first day of March, 1906.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow.
Applicants Agents.

COMPLETE SPECIFICATION.

"Improvements in Friction Clutches".

We, ALBION MOTOR CAR COMPANY LIMITED, of South Street, Scotstoun, in the County of Lanark, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same place, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention relates to clutches of the "Weston" type, in which are series of discs, alternate ones carried by driving and driven members of the clutch and in which friction between the discs when they are pressed together transmits the drive. In order to more or less definitely free the discs from each other when the clutch is released, springs acting between adjacent discs of one or of each series have been proposed or used, but it is obvious that such an arrangement is ineffective in a measure in that, these springs only separate discs of the one series from adjacent ones of the same series, and even although the springs be applied to both series there is nothing to separate the discs of one series from those of the other series; that is to say, although the springs in both series even operate perfectly the adjacent discs of opposite series are still free to adhere to one another on one of their faces.

This defect has been overcome by having upon each disc of one series a rider or equivalent device carrying springs pressing against the adjacent discs of the other series on each side of that one. The same effect may be arrived at effectively in a more simple manner and that is the object of the present invention.

According to the present invention there is cut in each face of each disc of one series (it will be seen that it is unnecessary that the device should be applied to both series of discs) a number of recesses. The recesses are preferably radial and alternate on opposite sides of the discs in order that they may be of sufficient depth for their purposes without, on the one hand, unduly weakening the disc or, on the other hand, requiring that it be of excessive thickness. The recesses, however, may be arranged tangentially or in other convenient manner instead of radially.

Within each recess a spring is fixed so that its free end or ends bears upon the adjacent disc of the other series. Means are preferably provided for limiting the outward movement of the free ends of the springs—so that they cannot at any time project more than a very small amount beyond the surface of the disc. Where the recesses are radial and extend to the edge of the disc the stops may very conveniently be formed by bending over the free ends of the springs so that they engage with the other surface of the disc, or with a recess cut in the edge of the disc.

In operation, the springs carried in the recessed discs simply bear upon the surfaces of the adjacent discs (the springs being made, of course, of a material sufficiently hard to resist the wear thus imposed upon them). They free the

discs equally when the clutch is released and when it is being put into gear they cause very gradual engagement—how gradual depending upon whether their ends be left free or, if stops be applied to them, the residual flexure remaining in the springs when they engage the stops.

It is very evident that the forms of springs used may be widely varied, for the essential feature of the invention is the provision upon both sides of one series of discs of springs which bear upon the adjacent discs (which are not provided with springs) of the other series. Therefore, may the recesses be dispensed with and the springs be formed integrally with the discs or the discs themselves be so formed as to act as springs.

In order that the invention and the manner of performing the same may be properly understood, there are hereunto appended three sheets of explanatory drawings throughout which like reference letters indicate like parts and in which Figure 1, Sheet 1, is an elevation of one form of the improved disc and springs, Figures 2 and 3, Sheet 2, being, as hereinafter explained somwhat diagrammatic sections to an enlarged scale of the same form, while Figures 4 and 5, are sections of modifications of that form. Figure 6, Sheet 3, is an elevation of an example in which the springs are formed integrally with the disc, while Figures 7 and 8, are sections of examples in which the discs themselves are so shaped as to form the springs.

According to the example shown in Figures 1 2 and 3, there is cut in each face of each disc of one series a number of recesses, A, B. The recesses are radial and alternate upon opposite sides of the disc in order that they may be of sufficient depth for their purpose without, on the one hand, unduly weakening the disc or, on the other hand, requiring that it be of excessive thickness. (It has already been explained that Figures 2 and 3, are diagrammatic, they are in so far that the recesses, A, B, are shown as being opposite one another—this being done for explanation and illustration of the action of the device).

Within the recesses, springs C, D, are fixed by rivets, E, in such manner that as shown in Figure 2, their free ends bear upon the adjacent discs, G, of the other series.

Thus, the springs, C, D, free the discs, upon which they are, equally from the adjacent discs, G, of the other series upon each side of them when the clutch is released and as is shown in Figure 2. When in this position the springs, C, D, which, of course, are of a material sufficiently hard to resist the wear thus imposed upon them, simply bear upon the surfaces of the adjacent discs.

When the clutch is put into gear, they cause very gradually engagement, their final position with the clutch fully in gear being that shown in Figure, 3.

It is, however, preferable to provide means for limiting the outward movement of the free ends of the springs, C, D,—so that they cannot at any time project more than a very small amount beyond the surface of the disc.

A convenient manner of forming these stops is shown in Figure 4. In this example, the free ends of the springs are bent over so as to form a hook-like part, H, which engages a notch, J, cut in the edge of the disc at the opposite side to the spring. Or, to the same end, and as shown in Figure 5, a rivet, K, may be loosely fixed to the free end of the spring. This rivet passes through an aperture in the disc and its large head, H, engages a recess, J, formed in the opposite face of the disc.

It is obvious that the same end may be gained and the necessity for recesses obviated if the discs be made of suitable material sufficiently thin for springs to be formed integrally with it. Such an example is shown in Figure 6, pairs of springs, C, C, D, D, being formed by slitting the edges of the disc tangentially in known manner, alternate pairs of the blades thus formed being set in opposite directions. This arrangement is not to be confounded with those known arrangements in which springs formed in this manner bear upon the next disc of the same series, as the springs just described are adapted to bear upon the adjacent and springless discs of the opposite series.

Again, the formation of springs by slitting may be obviated, the discs being of a sufficiently thin and elastic material and so shaped—for example, of slightly dished or conical form as shown in Figure 7, or corrugated in wide and flat corrugations as shown in Figure 8—that they themselves form the separating springs. It is, of course, to be understood that this formation is known, the essence of its present application being its use in connection with alternate plain discs.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a friction clutch of the type described, a series of plain discs and a series alternating therewith of discs adapted to equally separate discs of both series from each other, as described.

—2— In a friction clutch of the type described, a series of plain discs and a series alternating therewith of discs having springs pressing upon each of the adjacent plain discs, as described.

—3— In a friction clutch of the type described, discs having recesses in both faces and springs arranged in the recesses and the free ends of which are adapted to bear upon the faces of adjacent discs, as described.

—4— In a friction clutch of the type described, discs having recesses in both faces and springs arranged therein and means for limiting the outward travel of the springs, as described.

Dated this Twenty eighth day of September, 1906.

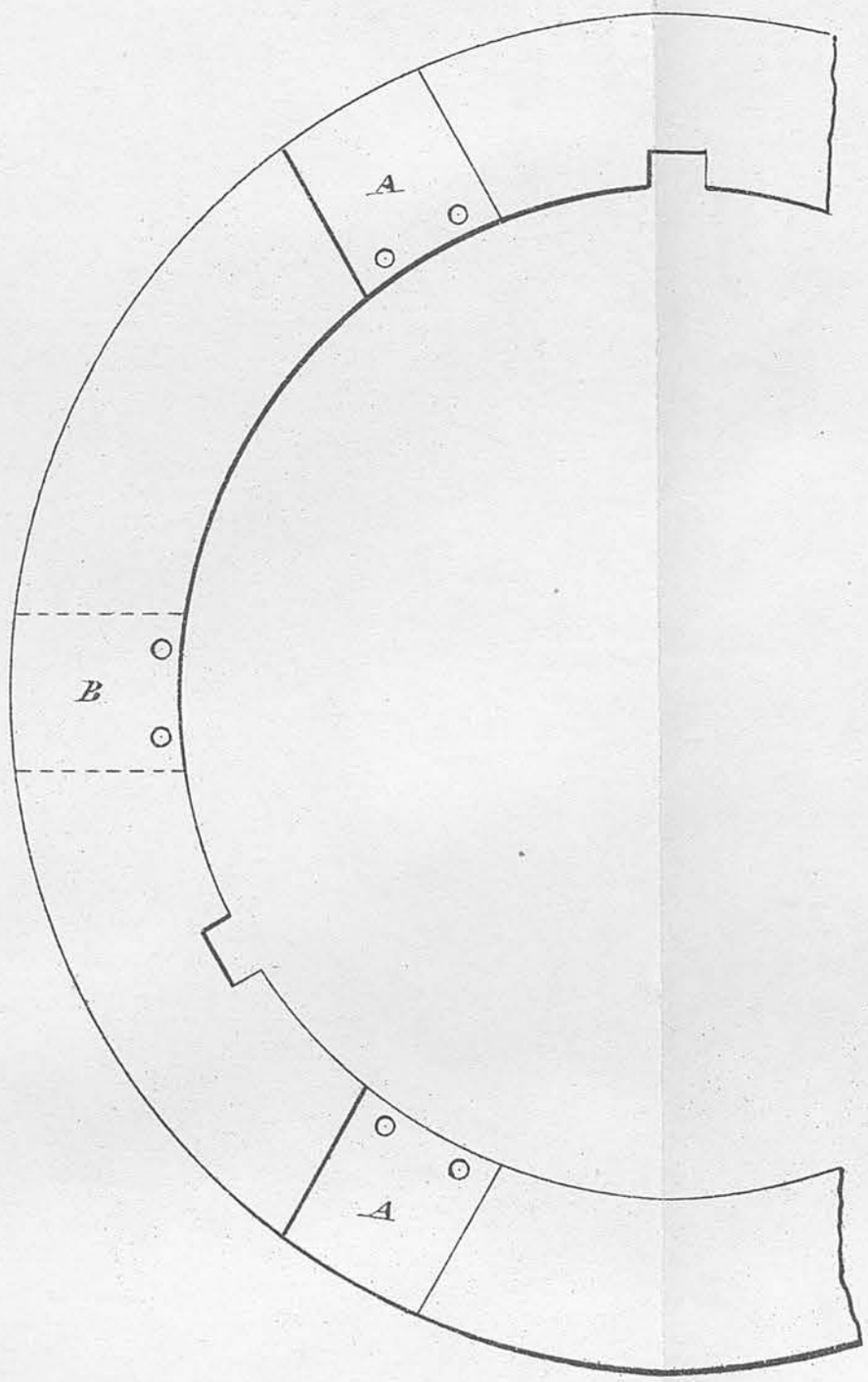
EDMUND HUNT & Co.,
Chartered Patent Agents,
121 West George Street, Glasgow.
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1907.

[This Drawing is a reproduction of the Original on a reduced scale.]

SHEET 1.

FIG. 1.



SHEET 2.

FIG. 2.

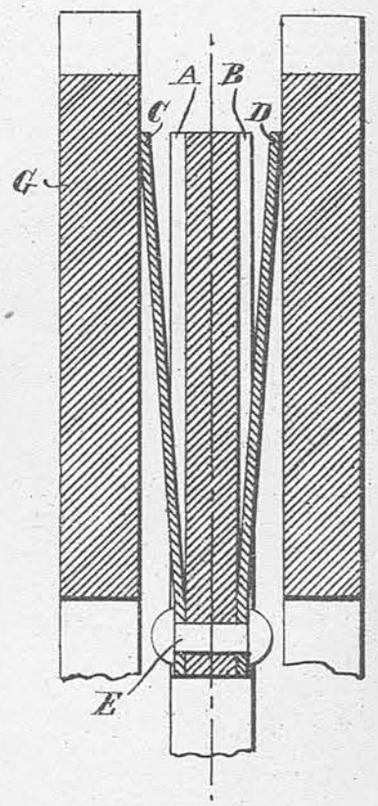


FIG. 3.

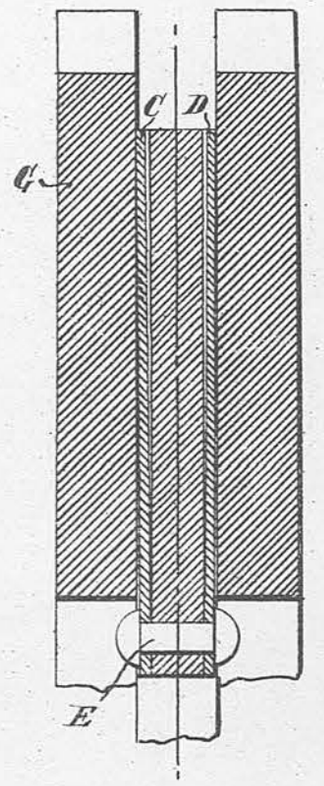


FIG. 4.

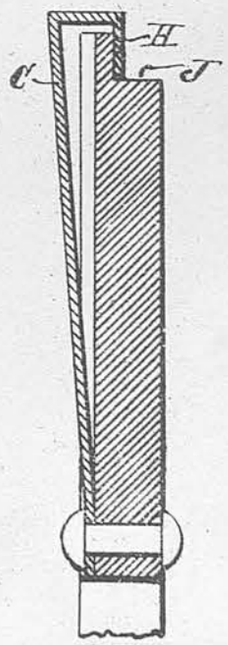
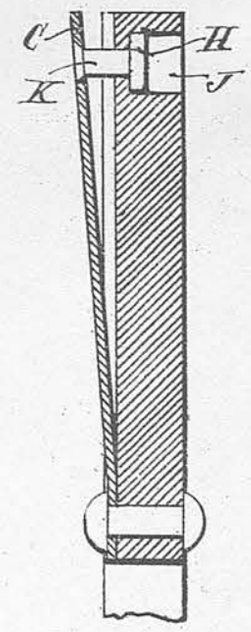


FIG. 5.



Malby & Sons, Photo-Litho.

FIG. 6.

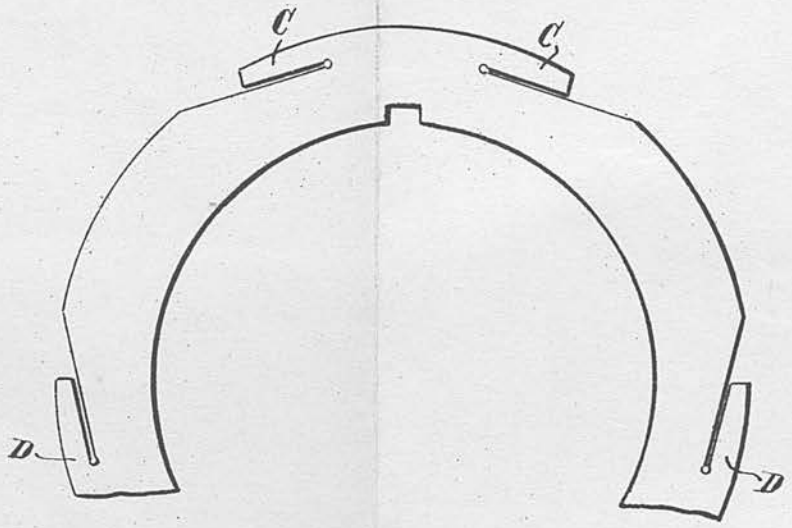


FIG. 7.

FIG. 8.

[This Drawing is a reproduction of the Original on a reduced scale.]

Malby&Sons, Photo-Litho.

An Improved Plate Friction Clutch.

The springs E tend always to throw these frictional surfaces into contact with the plate member J^2, and the clutch is actuated for disengagement in the following manner;—Upon the end of the sleeve D^2 formed on the dished disc D is secured a collar K. On the outer sleeve D^5 is mounted freely a sleeve K^1 having an inwardly projecting flange K^2 between which and the collar K is a ball bearing K^3. A second small inwardly projecting flange L secured on the end of this sleeve engages behind the collar K and prevents separation of the ball bearing, while an outwardly projecting flange M having a renewable face M^1 is adapted to be engaged by the usual tappet to actuate the clutch.

To maintain centering of the sleeves D^2, D^5 there is arranged between them a bush N.

Lubricant is supplied to the spherical parts F^1, G, and to the crown clutch parts H, H^1 by a central aperture N^1 in the shaft. It is kept in contact with the crown clutch parts by an inwardly projecting flange N^2 secured to the part H^1, and should any lubricant escape beyond that flange N^2 it is prevented from reaching the frictional surfaces by an inwardly projecting flange P secured to the dished disc D, lubricant lodging behind that flange being finally discharged by apertures P^1 and further by apertures A^3 if desired.

An inwardly projecting flange R on the inner periphery of the disc A prevents radial discharge of lubricant in that direction.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In a clutch of the type set forth; a universal joint between the shafts of the driving and driven members comprising a sleeve bearing a spherical part and free upon the shaft to which one member is secured and a counterpart part on the shaft of the other member engaging the spherical part of the sleeve.

2. In the universal joint device forming the subject-matter of the foregoing claim hereof, a spider free upon the free sleeve and carrying one member of the clutch and driving means between that member and a counterpart part engaging the spherical part of the free sleeve.

3. In combination with the subject-matter of the foregoing claims hereof, a driving member having an annular disc bearing a frictional annulus and a dished disc bearing a like annulus one on either side of the plate member and both discs removably secured in position by stud bolts as described.

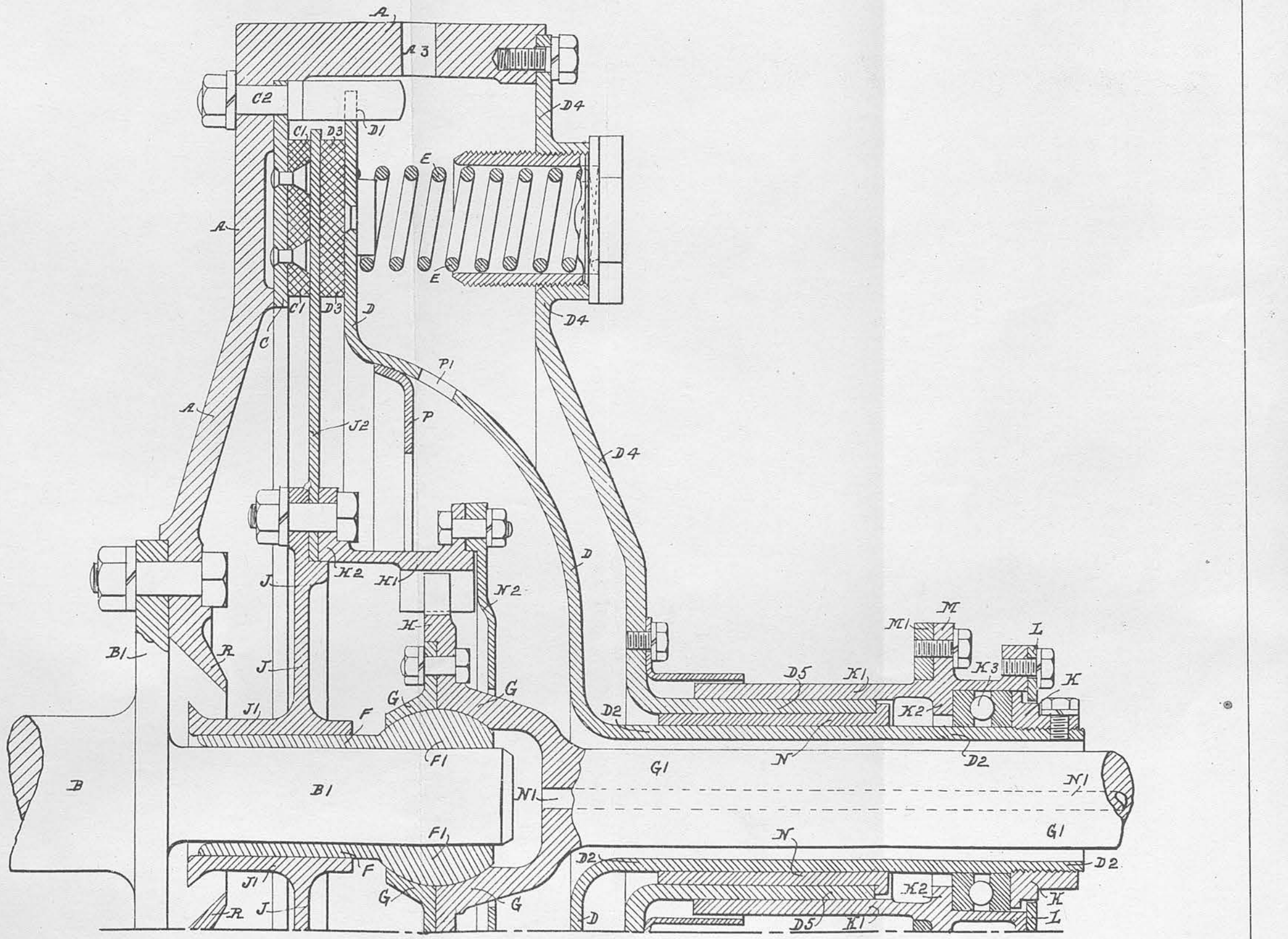
4. In combination with the subject-matter of the foregoing claims hereof, clutch actuating means substantially as hereinbefore described with reference to the accompanying drawings.

5. The improved clutch substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Twenty-second day of July, 1910.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1910.



Malby & Sons, Photo-Litho.

21.

N° 18,837 A.D. 1911

Date of Application, 22nd Aug., 1911

Complete Specification Left, 7th Feb., 1912—Accepted, 25th Apr., 1912

PROVISIONAL SPECIFICATION.

Improvements in Friction Clutches of the Plate Type.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention relates to friction clutches of the plate type in which one member consists of a plate adapted to be grasped between the other member consisting of two plates one on either side thereof.

The invention has for object to provide a clutch of this type particularly applicable in motor vehicles in that with it, the members are instantly and totally freed upon disengagement—thus "drag" or continued rotation of the driven member is avoided and the necessity for clutch stops or brakes minimised or obviated.

According to the invention the single-plate member is axially movable upon its driving or driven shaft or sleeve, the freedom of that movement being, however, checked by radially acting spring controlled plungers or kindred devices acting frictionally between the parts. The plates of the double plate member—one plate of which is on either side of the single plate member—are operated by any convenient devices from a muff or equivalent to simultaneously advance towards and retire from the faces of the single plate member for engagement and disengagement of the clutch. The engaging faces of either the single plate member or of the plates of the double plate member may be fitted with frictional material and either the single or the double member may be the driver but preferably the double member.

According to a simple and illustrative example, there is carried on the driven shaft the disc-like plate of the single plate member. This plate is on a feather or feathers or is otherwise so carried that it may move axially on the shaft but its movement is constrained by frictional devices, such as radially-moveable spring controlled plungers acting between it and the shaft or a part thereon.

Upon the shaft driving co-axial with this shaft and with its rim enclosing the single plate member and also, as hereinafter explained, the double-plate member, is a drum—very conveniently the fly-wheel of an internal combustion motor. The open end of this drum is closed by a cover plate having a central spigot guide.

The inner of the two plates of the double member is annular in form, the outer disc-like. The inner plate has lateral projections engaging apertures in or near the edge of the outer plate and projecting beyond them. The two plates are pressed towards one another to engage the single plate member between them by springs arranged between them and the web and cover of the drum respectively, while preferably they are guided upon feathers or the like in the interior of the drum to prevent rotation relatively to the said drum. They are drawn apart to disengage that member by levers radially arranged, pivoted at their centres upon the cover plate and engaging at their outer ends the projections on the annular inner plate, and at their inner ends a collar on a sleeve laterally projecting from the outer disc-like plate and guided within the spigot of the cover plate. On this sleeve is a muff or equivalent for operating the clutch.

In action, since the single plate member can move axially, it will adjust itself

[*Price 8d.*]

to any inequality in the pressure exerted upon it by the two plates of the double member when they engage it—thus there is no axial stress upon the parts. But since that single plate member is only stiffly movable, the double member plates when released move equally away from it on each side, thus leaving it perfectly free (as its resistance to axial movement prevents it sticking to one or the other) and thus preventing that well known "drag" which is so detrimental in the action of plate clutches as hitherto generally constructed.

Dated this Twenty-first day of August, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Friction Clutches of the Plate Type.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to friction clutches of the plate type in which one member consists of a plate adapted to be grasped between the other member consisting of two plates one on either side thereof.

The invention has for its object to provide a clutch of this type particularly applicable in motor vehicles, in that with it the members are instantly and totally freed upon disengagement—thus "drag" or continued rotation of the driven member is avoided and the necessity for clutch stops or brakes minimised or obviated.

According to the invention, the single-plate member is axially movable upon its driving or driven shaft or sleeve, the freedom of that movement being, however, checked by radially acting spring controlled plungers, or kindred devices acting frictionally between the parts. The plates of the double plate member—one plate of which is on either side of the single plate member—are operated by any convenient devices from a muff or equivalent to simultaneously advance towards and retire from the faces of the single plate member for engagement and disengagement of the clutch. The engaging faces of either the single plate member or of the plates of the double plate member may be fitted with frictional material, and either the single or the double member may be the driver, but preferably the double member.

In order that the invention and the manner of performing the same may be properly understood, there is hereunto appended a sheet of explanatory drawings illustrating in longitudinal sectional elevation an example of plate clutch made according to the invention.

According to this simple and illustrative example, there is carried on the driven shaft A the disc-like plate B of the single plate member. Upon this plate B is a central boss B^1 embracing the shaft A and carried on a feather B^2, so that while rotating this shaft with it, it is free to move axially. Its axial movement upon the shaft is however constrained by a plunger B^3 engaging the shaft, located in a recess formed in the boss B^1, and controlled by a spring B^4. Preferably, there is a plurality of these plungers, and it is to be here pointed out that other frictional devices acting upon the shaft or a part thereon to the same end, may be alternatively employed, as may be other means permitting of axial movement of the disc—for example the shaft may be castellated or polygonal, and the boss counterpartly formed.

Improvements in Friction Clutches of the Plate Type.

Upon the driving shaft C, which is coaxial with the shaft A, is a drum C^1—very conveniently the fly-wheel of an internal combustion motor. The rim of this drum encloses the single plate member B, and also as hereinafter explained the double plate member. The open end of the drum is closed by a cover plate C^2 having a central spigot guide C^3.

The inner D of the two plates D, D^1 of the double member is annular in form, the outer D^1 disc-like. The inner plate D has lateral projections D^2 engaging apertures in or near the edge of the outer plate D^1 and projecting beyond them. These projections D^2 (of which in the present example there are three) engage between lugs D^3 on the interior of the rim of the drum C^1. Thus, rotation of the plates relatively to the drum is prevented. The two plates D, D^1 are pressed towards one another to engage the single plate member B between them by springs E arranged between them and thimbles E^1 in the web C^1 and cover C^2 of the drum respectively, and of which there are in the present example three equidistant sets. The plates are drawn apart to disengage that member B by levers G (three in the present example) radially arranged, pivoted at their centres between lugs G^1 on the cover plate and engaging at their outer ends the projections D^2 on the annular inner plate D, and at their inner ends a shoulder G^2 on the outer plate D^1 and from which laterally projects a sleeve H guided within the spigot C^3 of the cover plate C^2. On this sleeve is a muff H^1 with which there engages a usual lever H^2 for operating the clutch.

In action, since the single plate member B can move axially, it will adjust itself to any inequality in the pressure exerted upon it by the two plates D, D^1 of the double member when they engage it—thus there is no axial stress upon the parts. But since that single plate member is only stiffly movable, the double member plates when released move equally away from it on each side, thus leaving it perfectly free (as its resistance to axial movement prevents it sticking to one or the other) and thus preventing that well-known "drag" which is so detrimental in the action of plate clutches as hitherto generally constructed.

It is to be understood that the details of the carrying out of the invention may be very considerably varied—its essence lies not in these but in the provision of means for frictionally restraining the axial movement of the single-plate members. Thus either the single plate or the double plate member may be the driven member and the springs and other operating details may be varied—for example the springs may all act on one plate and the pressure be transmitted to the other plate through the plate operating lever.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

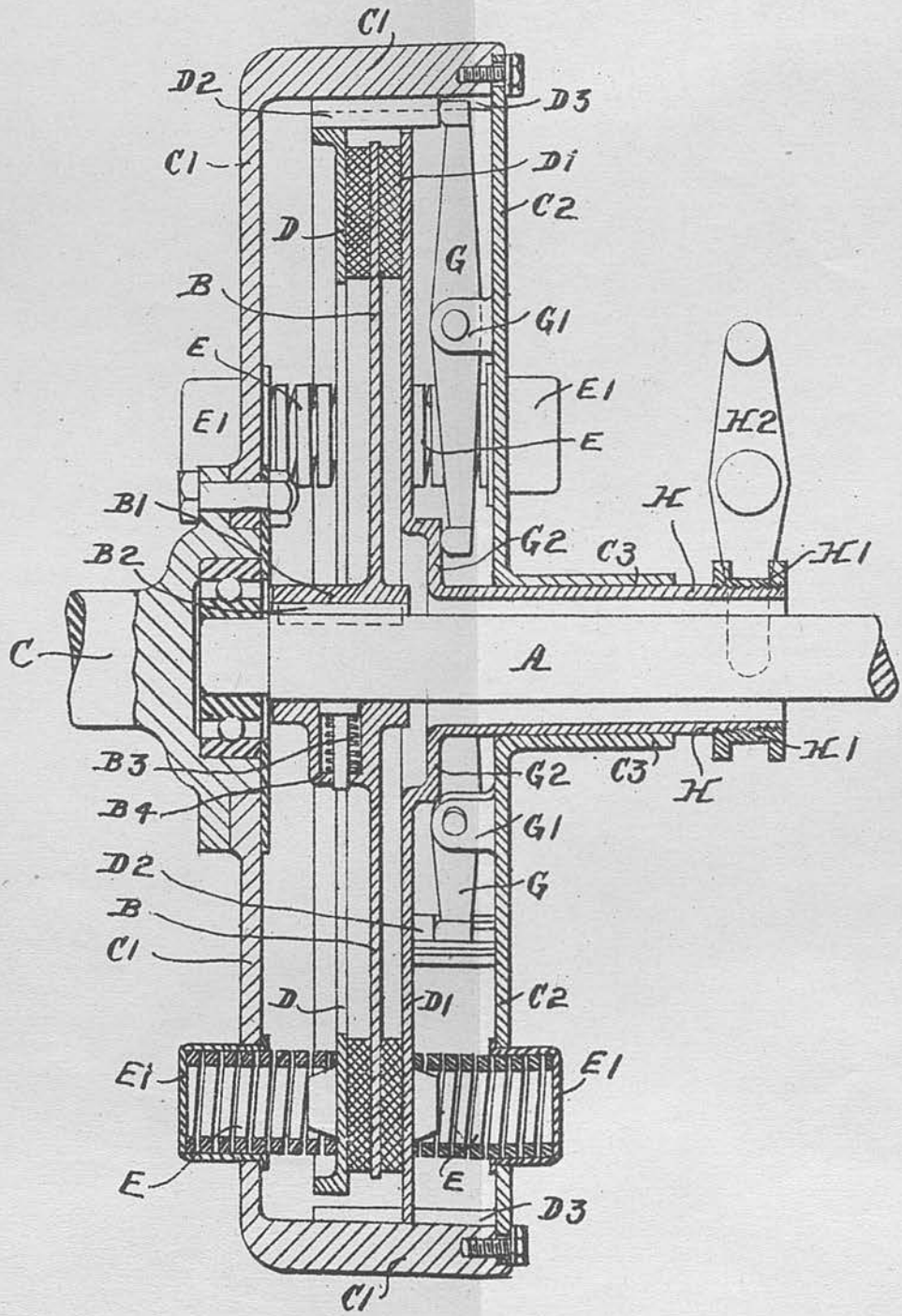
—1— In a clutch of the type described comprising a single plate member coacting with a double plate member; a single plate member rotating with its shaft or other driving or driven part, movable axially thereon but with the freedom of its axial movement checked by frictional devices, and means for causing the two plates of the double plate member to advance simultaneously towards and retire simutaneously from the single plate member which is between them.

—2— The improved friction clutch substantially as hereinbefore described with reference to the accompanying drawing.

Dated this Sixth day of February, 1912.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.



[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

22.

N° 3098 A.D. 1915

Date of Application, 26th Feb., 1915

Complete Specification Left, 30th July, 1915—Accepted, 18th Nov., 1915

PROVISIONAL SPECIFICATION.

Improvements in Disengaging Gear for Friction Clutches.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

In friction clutches particularly of those types in which directly axial spring pressure maintains driving contact, disengagement against this pressure entails considerable and objectionable end pressure upon one or other of the shafts which the clutch connects. The invention has for its object a disengaging gear in which end thrust due to the resistance of the engaging springs is eliminated.

According to the invention there is provided, on or surrounding the shaft driven by the clutch, a sleeve connected to the driving member of the clutch, and upon that sleeve a second sleeve connected in some cases to the driven member of the clutch, and in others to the outer of two driving members. On the two sleeves and adjacent to one another are flanges or equivalent parts. Between the flanges or equivalent parts and adapted to engage and separate them is a cam or cams. This cam (or cams) is mounted in a floating sleeve or casing embracing the two sleeves, and is operatively connected to the clutch-operating pedal or other means in any convenient manner. Means are provided to hold the sleeve or casing against rotation.

The flanges or equivalents on the sleeves are so placed that their separation frees the clutch, while, when they are allowed to approach one another, the clutch springs cause its engagement. Thus, since the outer casing or sleeve and the cam it carries are free to accommodate themselves endwise, the whole thrust of disengagement is taken by the flanges or equivalents on the sleeves.

Preferably ball bearings are arranged between the flanges and the sleeves and between them and the outer casing or sleeve—the races of which ball bearings may in some instances constitute what have been termed the flanges.

Preferably there is a cam mounted on either side of the outer casing or sleeve. These cams are carried on levers which at their outer ends are connected by a yoke piece pivoted at its centre on a lever on a transverse shaft connected to the clutch pedal or other operating means. A jaw on the boss of this lever may engage a feather on the sleeve to prevent rotation of the latter.

Dated this Twenty-fifth day of February, 1915.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

[*Price 6d.*]

COMPLETE SPECIFICATION.

Improvements in Disengaging Gear for Friction Clutches.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to friction clutches of "single-plate" type in which directly axial spring pressure maintains driving contact, disengagement against this pressure entailing in some cases considerable and objectionable end pressure upon one or other of the shafts which the clutch connects. The invention has for its object to provide an improved disengaging gear of the type in which end thrust due to the resistance of the engaging springs is eliminated.

According to the invention there is provided, on or surrounding the shaft driven by the clutch, a sleeve connected to the driving member of the clutch, and upon that sleeve a second sleeve connected in some cases to the driven member of the clutch, and in others to the outer of two driving members. On the two sleeves and adjacent to one another are flanges or equivalent parts. Between the flanges or equivalent parts and adapted to engage and separate them is a cam or cams. This cam (or cams) is mounted in a floating sleeve or casing embracing the two sleeves, and is operatively connected to the clutch-operating pedal or other means in any convenient manner. Means are provided to hold the sleeve or casing against rotation.

The flanges or equivalents on the sleeves are so placed that their separation frees the clutch, while, when they are allowed to approach one another, the clutch springs cause its engagement. Thus, since the outer casing or sleeve and the cam it carries are free to accommodate themselves endwise, the whole thrust of disengagement is taken by the flanges or equivalents on the sleeves.

Preferably ball bearings are arranged between the flanges and the sleeves and between them and the outer casing or sleeve—the races of which ball bearings may in some instances constitute what have been termed the flanges.

Preferably there is a cam mounted on either side of the outer casing or sleeve. These cams are carried on levers which at their outer ends are connected by a yoke piece pivoted at its centre on a lever on a transverse shaft connected to the clutch pedal or other operating means. A jaw on the boss of this lever may engage a feather on the sleeve to prevent rotation of the latter.

An example of the improved clutch-operating means is shown upon an accompanying sheet of explanatory drawings, Figure 1 thereof being a sectional elevation of a well known type of plate clutch to which the means are applied, and Figure 2 a plan of a detail.

In this example a sleeve A surrounds the driven shaft B and is formed on one of the annular disc driving members C of the clutch. On a bush D on this sleeve is a second sleeve E formed on a cover plate F secured to a flywheel G which forms one of the driving members of the clutch, the driven disc H of which, fast on the shaft B, is engaged between the two driving members C, G, by the pressure of springs J.

On the sleeves E, A respectively are ball journal bearings K, L and thrust washers M, N enclosed in a longitudinally divided casing O. In this casing O are pivoted two levers P, R having on them cams S engaging between the thrust washers M, N which of course are normally thrown towards the cams by the pressure of the springs J. The levers P, R are connected by an equalising

yoke T pivoted at its centre on spherically-faced nuts which are in turn adjustably connected to a lever U on a clutch operating shaft V. The lever U has on it a projection W which engages between lugs X on the casing O, so holding the latter against rotation.

Since the casing O is free to move longitudinally, it will be seen that rotation of the cams S to free the clutch exert equal and opposite pressure upon the clutch members C, G forcing them apart without end thrust being set up either in the driving or the driven shaft.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a friction clutch having an inner disc engaged between two outer discs, sleeves operatively connected to the outer discs and one upon the other, and collars or equivalents upon the sleeves; cams between the collars and adapted to engage them, a casing embracing the collars and endwise movable relatively to them, a lever or levers pivoted in the casing and carrying the cams and a yoke piece to which the levers are connected pivoted at its centre and adjustably connected to a clutch operating shaft, as described.

—2— The improved friction clutch disengaging gear substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Twenty-ninth day of July, 1915.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.

A.D. 1915. FEB. 26. No. 3098.

ALBION MOTOR CAR CO. & another's COMPLETE SPECIFICATION. (1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

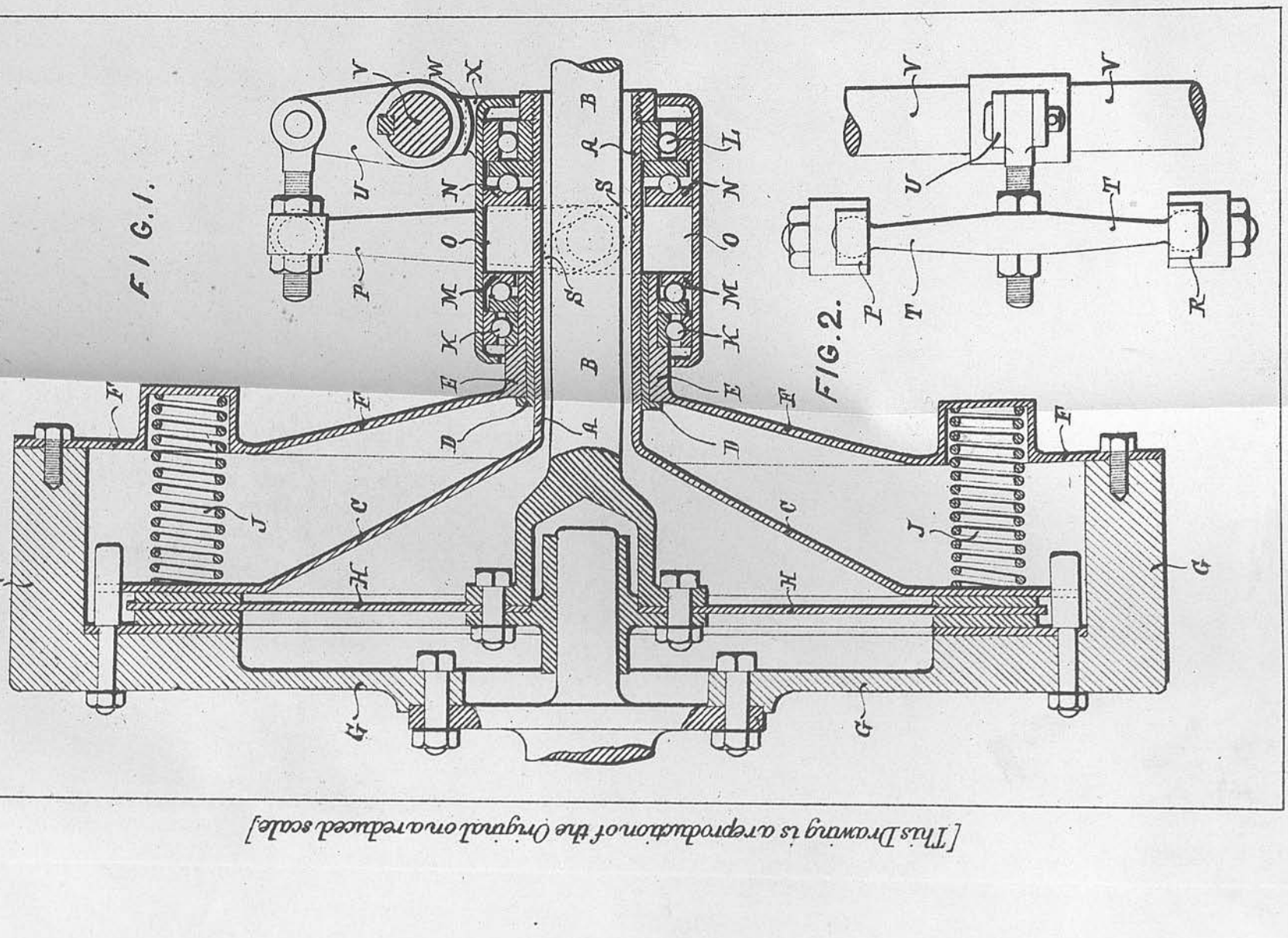


FIG. 2.

Malby & Sons, Photo-Litho.

N° 3099 A.D. 1915

Date of Application, 26th Feb., 1915
Complete Specification Left, 4th Aug., 1915—Accepted, 23rd Sept., 1915

PROVISIONAL SPECIFICATION.

Improvements in connection with Friction Clutches of the Plate Type.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention has for its object to provide in friction clutches of the plate type an improved form of universally jointed clutch or driven shaft, such that the driven member of the clutch is maintained coaxial and in parallel plane of rotation with the driving member and a minimum length is occupied. There are also provided means for throwing the driven member—a disc—out of contact with the driving discs which engage it.

According to the invention the driven disc is carried on a sleeve on the end of the driving shaft. This sleeve is articulated to the driven shaft by a ball-and-socket joint, the ball of which is preferably on the sleeve. The drive from the driven disc is taken to the driven shaft by a flexible coupling of the well-known spring plate type the members of which are interconnected between bosses on the driven disc and bosses on a spider on the driven shaft.

At its rear end the driven clutch shaft is fashioned to make driving connection with the spider of a second flexible coupling making connection between the driven shaft and for example the first motion shaft of a gear box. This spider is adjustable endwise upon the driven shaft and may be locked in position when adjusted. The spider also carries the hollow member of a ball and socket joint, the ball of which is free to move endwise on the gear box shaft an amount determined by a collar thereon. This ball is urged away from the driven shaft by a spring arranged in compression between it and a collar on the end of the gear box shaft.

With this arrangement it will be seen that the driven disc is at all times in line and in axial coincidence with the driving discs, while, when the clutch is disengaged by the withdrawal of one of the driving discs, the driven disc is constrained by the spring device at the end of the driven shaft to leave the other driving disc, with the result that it stands clear of both, as the other driving disc has already been moved clear of it by the act of declutching.

Dated this Twenty-fifth day of February, 1915.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

[*Price 6d.*]

COMPLETE SPECIFICATION.

Improvements in connection with Friction Clutches of the Plate Type.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to single-plate friction clutches of the type in which the driven member is on a sleeve on the driving shaft, and turns the driven shaft through a clutch or other suitable flexible coupling, there being also a ball and socket or universal joint between the sleeve and the driven shaft, and also in some cases a similar joint between the driven shaft and a final shaft; and the invention has for its object to provide an improved construction in which the driven member of the clutch is maintained coaxial and in parallel plane of rotation with the driving member and a minimum length is occupied, and in which there are also provided means for throwing the driven member—a disc—out of contact with the driving discs which engage it.

An illustrative example of the carrying out of the invention is shown in sectional elevation on an accompanying sheet of explanatory drawings.

In this example, the driven disc A of the clutch is carried on a sleeve A^1 on the end of the driving shaft B. This sleeve A^1 is articulated to the driven shaft C by a ball-and-socket joint, the ball C^1 of which in the present instance is on the sleeve. The drive from the driven disc A is taken to the driven shaft by a flexible coupling, preferably and as here shown of the well known spring plate type, the plate members C^2 of which are interconnected between bosses A^2 on the driven disc A and bosses on a spider C^3 on the driven shaft C.

At its rear end the driven clutch shaft C is fashioned to make driving connection with the spider D of a second flexible coupling, the second spider D^1 of which is fast on the end of a final shaft E which may be taken as being the first-motion shaft of a gear box. The spider D is split so that it may be adjusted endwise upon the shaft C and carries one member—in this instance the cup D^2—of a ball-and-socket joint, the ball E^1 of which is free to move endwise under control of a spring E^2 on the reduced end of the final shaft E, being urged towards that shaft by the spring which acts between it and a collar E^3 on the end of the shaft.

With this arrangement it will be seen that the driven disc A is at all times in line and in axial coincidence with the driving discs F, F^1 which engage its faces, while, when the clutch is disengaged by the withdrawal of one of the driving discs F, the driven disc is constrained by the spring E^2 at the end of the driven shaft to leave the other driving disc F^1 by an amount equal to the clearance at H, with the result that it stands clear of both, as the first mentioned driving disc F has already been moved clear of it by the act of declutching.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a friction clutch of the type described; in combination a driven disc on a sleeve on the end of the driving shaft, a driven shaft articulated to the sleeve by a ball-and-socket joint, a flexible coupling connecting the driven disc to the driven shaft, a final shaft, a flexible coupling between it and the driven shaft, said coupling being adjustable endwise, and a ball-and-socket connection

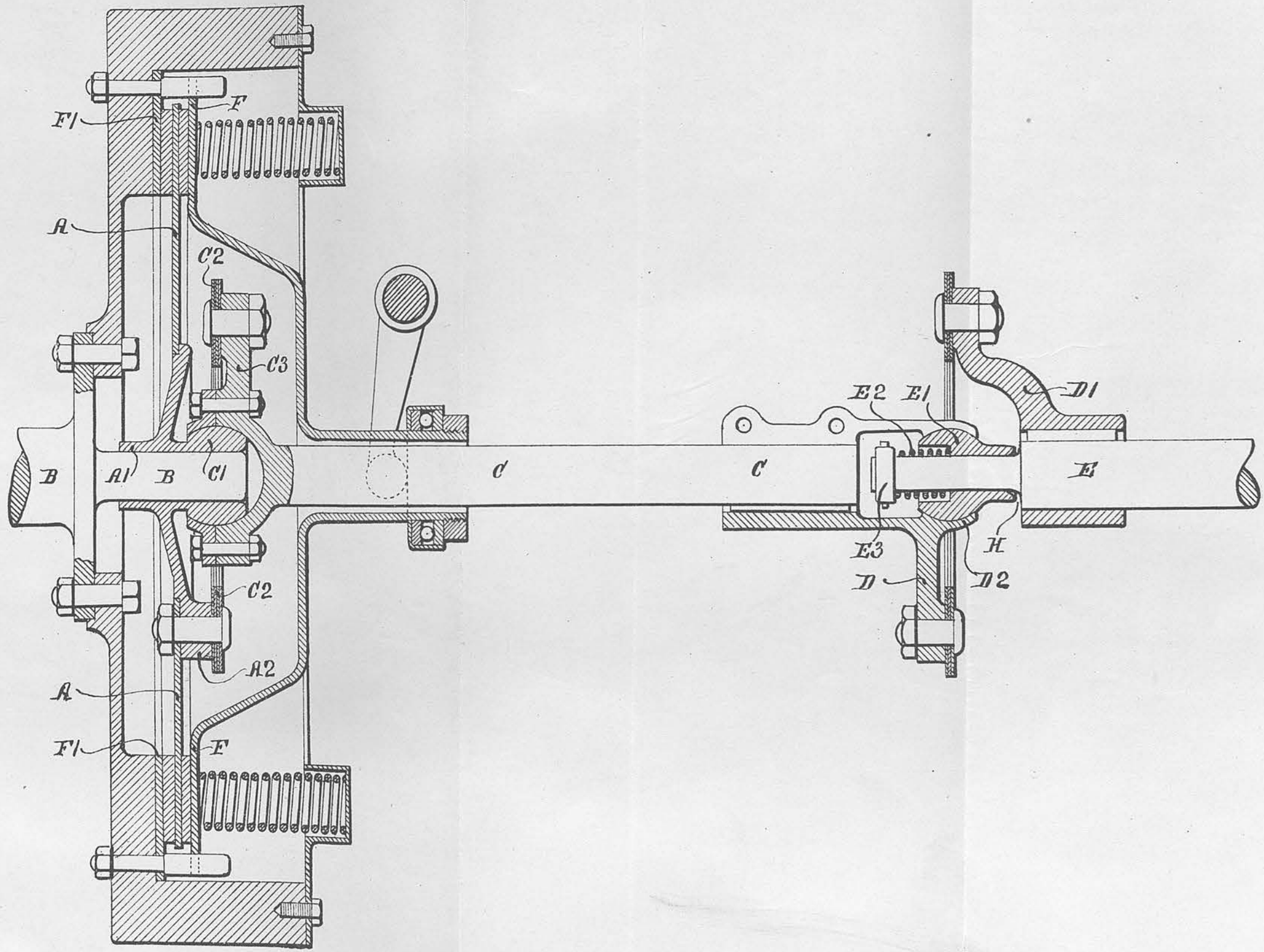
between the driven and final shaft, said connection being movable endwise on the final shaft and urged towards that shaft by a spring, as and for the purposes set forth.

—2— The shafting and connections for friction clutches of the plate type substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Third day of August, 1915.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.



[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

[Second Edition.]

24.

N° 23,082 A.D. 1908

Date of Application, 30th Oct., 1908

Complete Specification Left, 14th Apr., 1909—Accepted, 19th Aug., 1909

PROVISIONAL SPECIFICATION.

"Improvements in Valves and Valve Gear of Internal Combustion Engines."

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention has for its object to provide a simple and effective form of valves and valve gear for internal combustion engines especially such as be operated by a hydrocarbon such as petrol vaporised.

According to the invention, the inlet and exhaust valves consist of trunk pistons operated by connecting rods from cranks or eccentrics upon a shaft or shafts parallel with the engine crank shaft and driven therefrom. The pistons operate in cylinders axially parallel with the motor cylinder which they serve and in which are circumferential ports communicating with the motor cylinder and covered and uncovered by the valve pistons in due sequence for the distribution of the charge to the motor cylinder and its exhaust therefrom.

According to a simple example, the valve cylinder, water-jacketed as usual, has above the piston a space in open communication with the mixture inlet (or with the exhaust outlet as the case may be—both valves being similar). Lower in the valve cylinder is an annular port communicating with the cylinder. The valve piston has in it a diaphragm above which project its walls. These walls have in them ports controlling communication with the annular cylinder port and situated immediately above the said diaphragm.

Above the annular cylinder port, and forming a working lip for the valve piston, is an L shaped piston ring having an outwardly projecting flange held between the top of the valve cylinder proper and a junk ring part made in a separate piece. This piston ring is split and is turned to such a diameter relatively to the piston it embraces as to form the reverse as it were of an ordinary piston ring, the split in the ring being suitably tongued to prevent leakage. In order that leakage may be avoided, there is no port in the upstanding piston wall opposite the split in the ring, which ring is, of course, held against rotation by any suitable means. Usual piston rings are provided in the lower part of the valve piston.

Preferably, the inlet and exhaust are arranged at opposite sides of the cylinder, and each is operated from a separate shaft driven from the engine crank shaft and parallel therewith. That is to say, in a multiple cylinder engine, the inlet valves on one side of the motor cylinder are operated from one shaft, and the exhaust valves on the other side are operated by a second shaft.

Alternatively, the manifold ports in the valve piston walls may be dispensed with, the edge of the wall itself acting to control the annular port in the cylinder, or to control manifold ports in the cylinder wall, in which case an ordinary piston ring may take the place of the junk ring.

Dated this Twenty ninth day of October, 1908.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

[Price 8d.]

PRICE 6d.

COMPLETE SPECIFICATION.

"Improvements in Valves and Valve Gear of Internal Combustion Engines."

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has for its object to provide a simple and effective form of internal combustion engine, (especially such as be operated by a hydro carbon, such as petrol vaporised) of the type in which the inlet and exhaust valves consist of trunk pistons operated by connecting rods from cranks or eccentrics upon a shaft or shafts parallel with the engine crank shaft and driven therefrom. In an engine made according to the invention the pistons operate in cylinders axially parallel with the motor cylinder which they serve, and in which are circumferential ports communicating with the motor cylinder, and covered and uncovered by the upstanding ported walls of the valve pistons in due sequence and in known manner for the distribution of the charge to the motor cylinder and its exhaust therefrom, the inlet and exhaust ports being in the otherwise closed ends of the valve cylinders and above the pistons.

In order that the invention and the manner of performing the same may be properly understood, there are hereunto appended two sheets of explanatory drawings showing an example of the improved form of engine, Figure 1, Sheet 1, being a transverse vertical section, and Figure 2, Sheet 2 a sectional plan corresponding therewith.

According to this example there are provided upon either side of the crank shaft A of the engine a shaft B operating the exhaust valve (or valves in the case of a multiple cylinder engine) from a crank (or cranks) B^1 thereon, and a shaft C similarly operating by a crank (or cranks) C^1 thereon the inlet valves, both shafts B, C being driven from the main crank shaft A which rotates in the direction of the arrow in Figure 1, the valve shafts of course rotating reversely.

Connecting rods B^2 C^2 connect the cranks B^1, C^1 to trunk valve-pistons B^3, C^3—exhaust and inlet respectively—operating in valve cylinders D, E parallel with the motor cylinder F and, like it, water jacketted.

Above the pistons B^3, C^3 the valve cylinders D, E have spaces in open communication with the exhaust D^1 and the inlet E^1 respectively. Lower in each valve cylinder is an annular port G communicating with the motor cylinder by a passage H. Each valve piston B^3, C^3 has in it a diaphragm J above which project its walls. The projecting walls have in them manifold ports K, immediately above the diaphragms J and controlling communication with the annular cylinder ports G.

Above the annular cylinder ports G and forming working lips for the valve-piston B^3, C^3 are L-section piston rings L having outwardly projecting flanges L^1 held between the tops of the valve cylinders proper (D, E) and a junk ring part M (which also comprises the valve cylinder cover). These piston rings L are split as may be seen in Figure 2, and are turned to such a diameter relatively to the pistons they embrace as to form the reverse as it were of ordinary piston rings, the split in the ring L being provided with a tongue L^2 to prevent leakage and secured to the cylinder. In order to still further avoid leakage, the joint

in the ring is arranged to be between two of the piston manifold ports K—that is, opposite an unpierced part of the upstanding piston wall.

Usual piston rings N are provided in the lower parts of the valve pistons.

The engine illustrated has two cylinders, and in Figure 2 will be clearly seen without further description, the manner in which single inlet and exhaust passages may be arranged for each pair of cylinders or for a greater number of cylinders *en bloc*, and that the exhaust valves on one side and the inlet valves on the other side in an engine with two or with more than two cylinders may all be operated from shafts, one on either side of the engine crank shaft and parallel therewith.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— In an internal combustion engine, the specific combination of known integers to wit:—piston valves operating in valve cylinders parallel with the engine cylinder and in which are annular ports communicating with the cylinder, there being separate valves for inlet and for exhaust driven from separate shafts parallel with the crank shaft; upstanding ported walls on the pistons co-acting with the annular ports in the cylinder walls and controlling communication between them and inlet and exhaust ports respectively in the otherwise closed valve cylinder ends, as described.

—2— The combination and arrangement of parts constituting the improved internal combustion engine, substantially as hereinbefore described, and as shown in the accompanying drawings.

Dated this Thirteenth day of April, 1909.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 39—125/11/1909.]

A.D. 1908. Oct. 30. № 23,082.

ALBION MOTOR CAR CO. [LTD.] & *another's* COMPLETE SPECIFICATION.

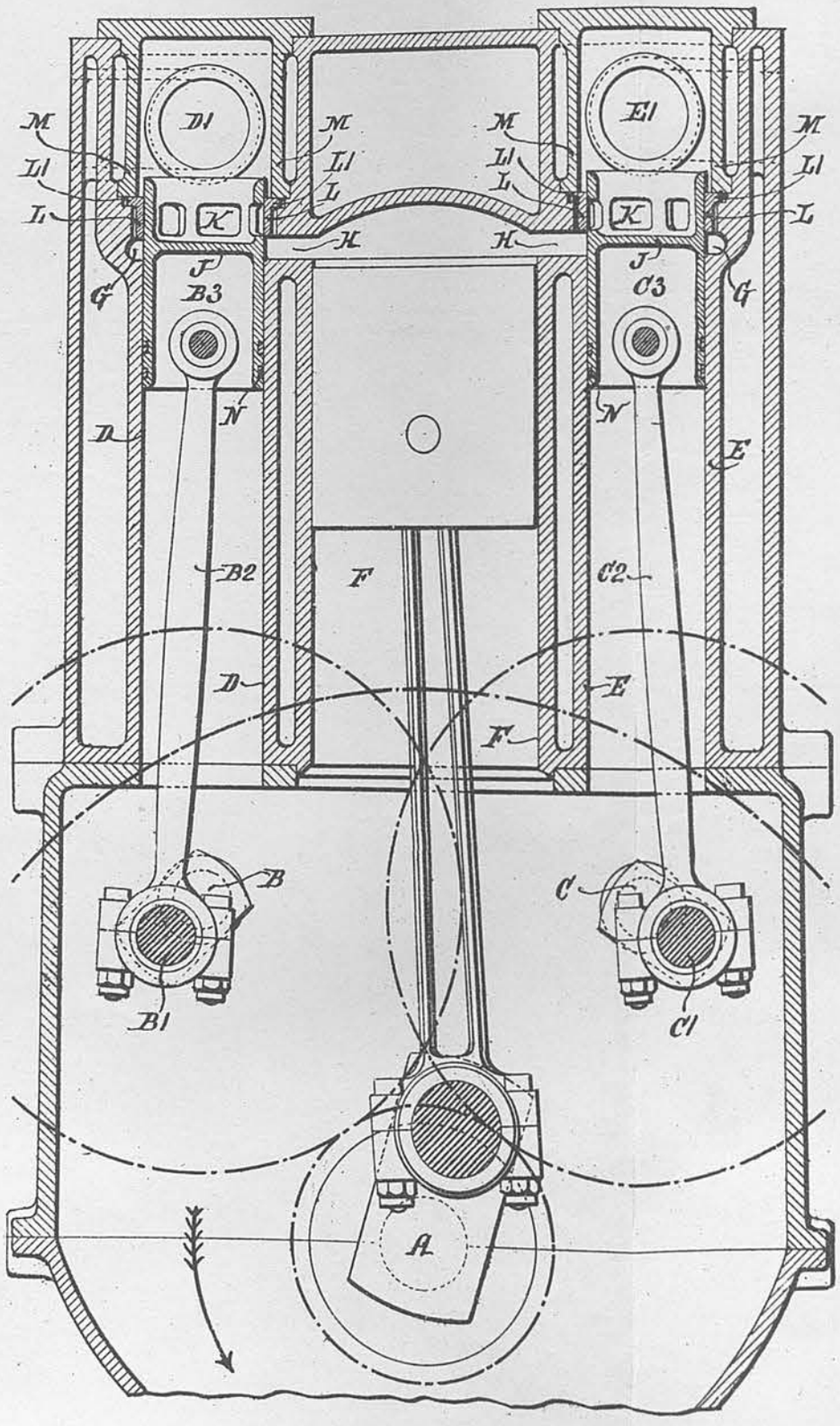
(2 SHEETS)

[This Drawing is a reproduction of the Original on a reduced scale.]

(2nd Edition.)

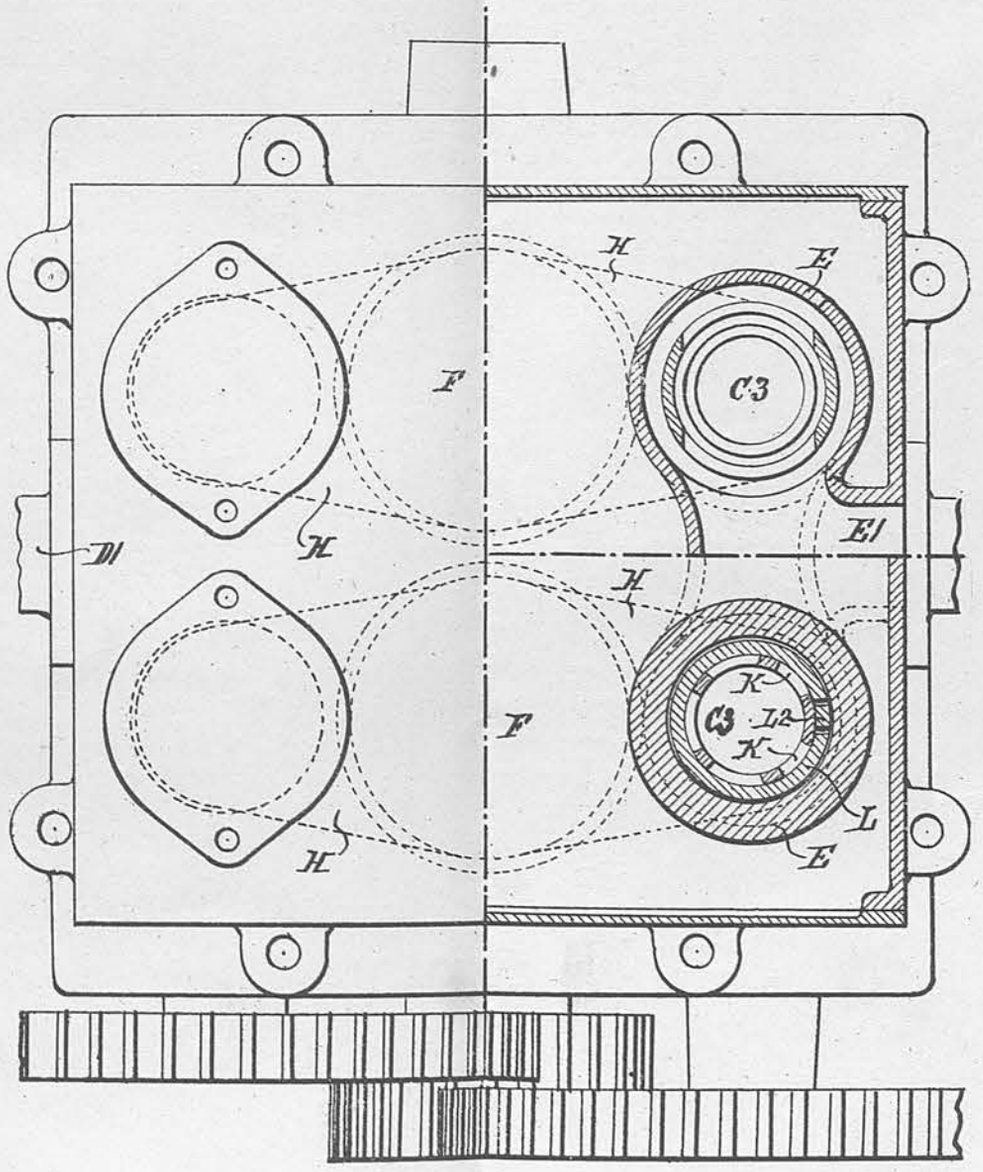
SHEET 1.

FIG. 1.



SHEET 2.

FIG. 2.



Malby & Sons, Photo-Litho.

25.

N° 24,705 A.D. 1911

Date of Application, 7th Nov., 1911

Complete Specification Left, 12th Apr., 1912—Accepted, 5th Sept., 1912

PROVISIONAL SPECIFICATION.

Improvements in Valves and Valve-gear for Internal-combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention has for its object to provide in four-stroke cycle internal combustion engines an improved form of valve mechanism of piston type, such and so operated that large port areas rapidly opened and closed are provided while constricted or pocketed areas in the combustion space are avoided.

A valve mechanism made according to the invention comprises essentially a piston valve working in a ported cylinder communicating with the combustion space of the engine cylinder and embraced for part of its length by a sleeve externally fitting and working in the valve cylinder. The piston valve and sleeve are operated in harmonic phase from a half speed shaft (driven from the engine crank shaft) in such manner and are so formed as to control inlet exhaust and cylinder ports that the various functions of the cycle take place in due sequence.

The valve cylinder may be axially parallel with the engine cylinder, may be axially at right angles thereto, or may be inclined, and the sleeve and piston valve may receive their motions from any convenient mechanism, but preferably they receive them from connecting rods operated by cranks on the half speed shaft, which cranks are at substantially 80 degrees to one another.

According to a simple illustrative example, the outer end of the piston valve is of a diameter to closely fit the valve cylinder and is provided with the usual piston rings. The inner end is embraced by the sleeve, the outer periphery of which is piston-ringed and fits the cylinder, while the piston valve is also piston-ringed where it works within the sleeve. Between the outer enlarged end of the piston valve and the outer end of the sleeve there is thus an annular space. In this annular space is a port communicating with the combustion space of the cylinder. Inlet and exhaust ports are controlled, the one by the sleeve end, the other by the outer enlarged end of the piston valve. It is apparent that as the piston valve moves out it uncovers the port controlled by it so that that port communicates with the annular space about that valve and so with the cylinder port, and in moving in covers that port. Similarly does the sleeve in moving in uncover and in moving out cover the port which it controls.

The sleeve and piston are moved by their operating mechanism in such sequence that first one port and then the other is uncovered and covered in the order necessary for the inlet of fuel and the discharge of exhaust.

Dated this Sixth day of November, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

[Price 8d.]
PRICE 6d.

ternal-combustion

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CKWOOD MURRAY, B.Sc.,
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The cranks R, S, are of course so placed as to perform these functio
necessary sequence for the inlet of fuel and discharge of exhaust for
of the engine, in the present case, in the direction of the arrow in Fig

The essence of the invention has already been set forth. It is clear
example illustratively set forth may be widely departed from withou
ing from that essence—valve and sleeve may perform the opposite
from those described, they may be set in any desired position relative
engine cylinder, they may be operated by any convenient mechanis
than that shown. A valve-cylinder liner may be dispensed with.

Having now particularly described and ascertained the nature of
invention and in what manner the same is to be performed, we dec
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within which is reciprocated a ported slide valve, but that what we cla

—1— A valve mechanism for internal combustion engines comp
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and valve controlling inlet and exhaust ports, and means for operati
in phase to control these ports in the necessary sequence.

—2— The valve mechanism for internal combustion engines sub
as hereinbefore described with reference to the accompanying drawing

Dated this Eleventh day of April, 1912.

EDMUND HUNT & Co
Chartered Patent Agent
121, West George Street, Gl
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd

the lay shaft T) it uncovers the exhaust ports K to the space between valve and sleeve and so to the cylinder ports G, and as it moves in, closes them. Similarly, the sleeve E in moving in (that is towards the lay shaft T) uncovers the inlet ports M to the cylinder ports G, and in moving out covers them. The cranks R, S, are of course so placed as to perform these functions in the necessary sequence for the inlet of fuel and discharge of exhaust for rotation of the engine, in the present case, in the direction of the arrow in Figure 1.

The essence of the invention has already been set forth. It is clear that the example illustratively set forth may be widely departed from without departing from that essence—valve and sleeve may perform the opposite functions from those described, they may be set in any desired position relatively to the engine cylinder, they may be operated by any convenient mechanism other than that shown. A valve-cylinder liner may be dispensed with.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that we are aware of a valve mechanism in which is a reciprocated ported sleeve within which is reciprocated a ported slide valve, but that what we claim is:—

—1— A valve mechanism for internal combustion engines comprising a piston valve working in a ported cylinder communicating with the combustion space of the engine cylinder and embraced for a part of its length which is of reduced diameter by an unported sleeve working also in the cylinder, sleeve and valve controlling inlet and exhaust ports, and means for operating them in phase to control these ports in the necessary sequence.

—2— The valve mechanism for internal combustion engines substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Eleventh day of April, 1912.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

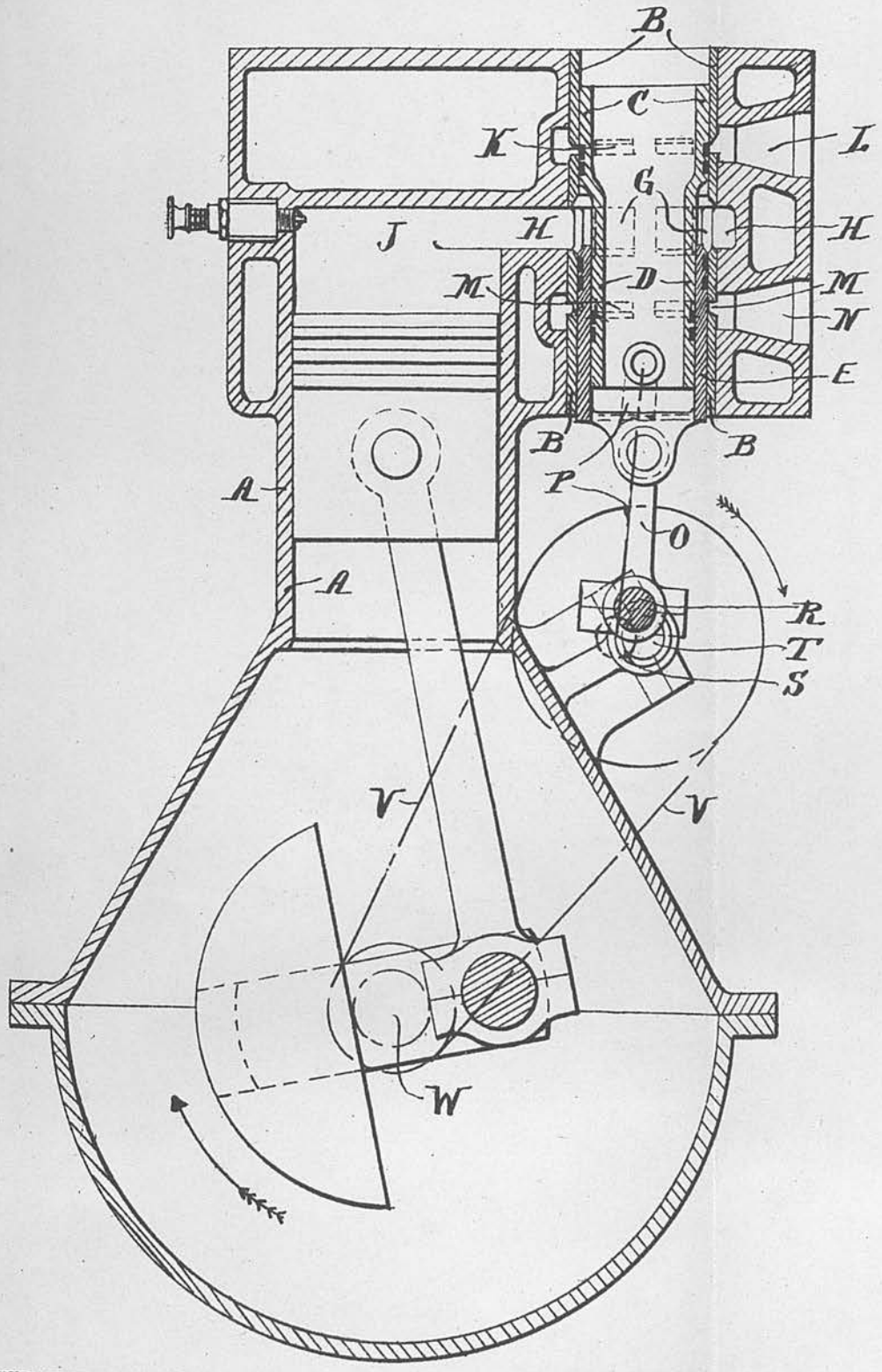
A.D. 1911. Nov 7. № 24,705.

THE ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

(2 SHEETS)

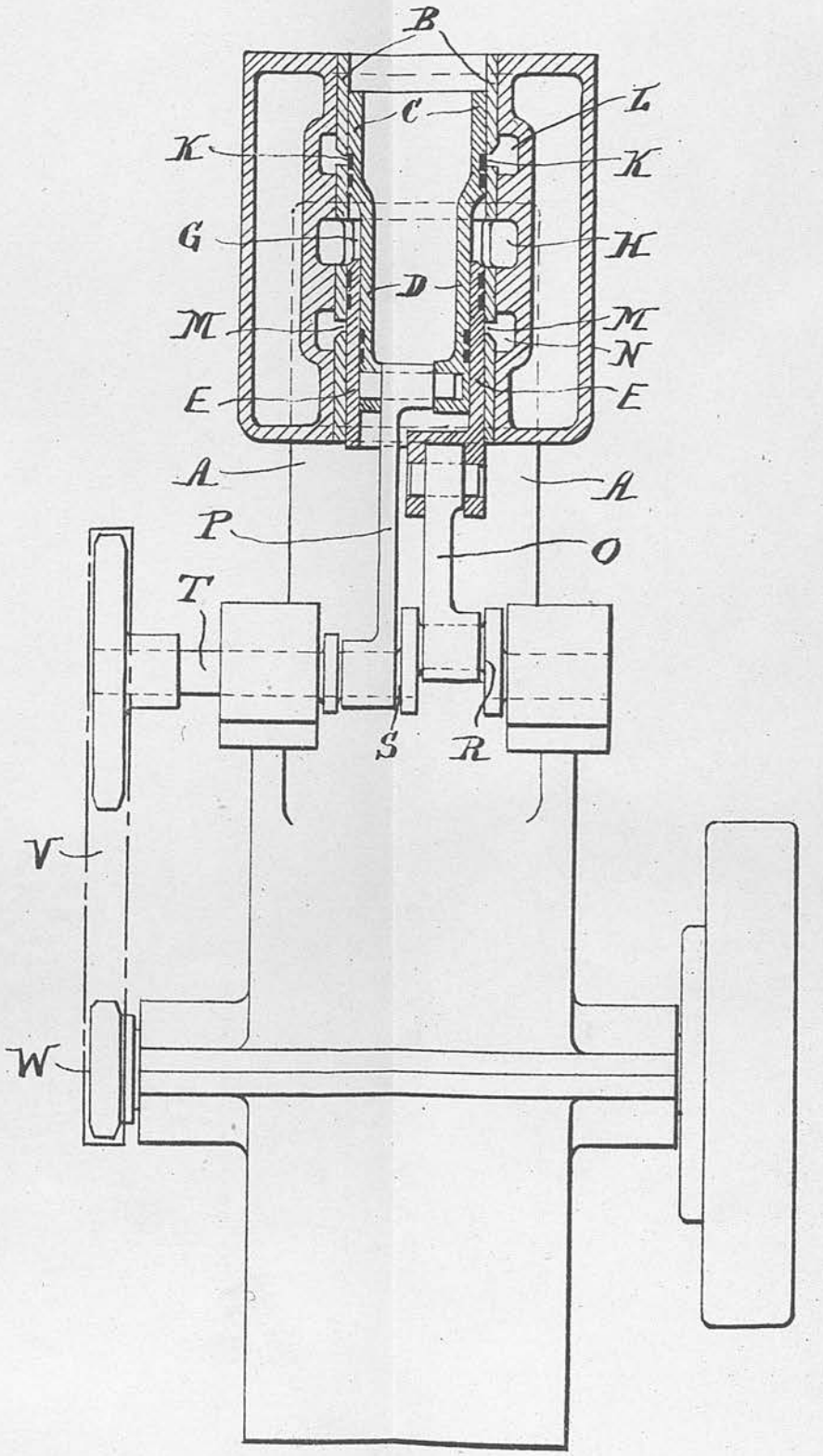
SHEET 1.

FIG. 1.



SHEET 2.

FIG. 2.



[*This Drawing is a full-size reproduction of the Original.*]

Malby & Sons, Photo-Litho.

26.

N° 1429 A.D. 1912

Date of Application, 18th Jan., 1912

Complete Specification Left, 29th June, 1912—Accepted, 12th Dec., 1912

PROVISIONAL SPECIFICATION.

Improvements in Piston-valve Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention relates to that type of internal combustion engine in which the valves are of simple trunk piston form uncovering the ports they control at the ends of their strokes in one direction, and has for its object to provide an improved and simplified arrangement and construction of parts such that the combustion space is very compact and quite unpocketed, while the whole of it may be machined—thus admitting of the production of exactly similar cubic contents in the several cylinders of a multicylinder engine.

According to the invention the valve cylinders are formed in the head of the main cylinder and are axially parallel therewith. They are preferably disposed diametrally opposite from one another and equidistantly from the axis of the main cylinder. They may be either in the plane of rotation or at right-angles thereto—that is say, they may be transverse to the crank shaft or in line therewith, or in a plane parallel to cylinder and at any angle to the crank shaft.

At the inner ends of the valve cylinders are annular inlet and exhaust ports, and the cylinders may be provided with liners.

Within each cylinder is a trunk piston valve, provided with usual piston rings and the inner end of which controls the ports.

The inlet and exhaust piston valves may both be operated by cranks, eccentrics, or cams, from a single longitudinal overhead shaft, or each from a separate shaft either directly by connecting rods or equivalents, or through rocking levers and links, or through triangulated connecting rod devices

It is at once apparent that, as has already been said, the whole of the combustion chamber may be machined. Moreover, removal of the piston valves gives very convenient access to the whole of the piston head for the removal of carbon deposits or other operation.

Dated this Seventeenth day of January, 1912.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Piston-valve Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc.,

[Price 8d.]

PRICE 6d.

of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to that type of internal combustion engine in which the valves are of simple trunk piston form uncovering the ports they control at the ends of their strokes in one direction, and has for its object to provide an improved and simplified arrangement and construction of parts such that the combustion space is very compact and quite unpocketed, while the whole of it may be machined—thus admitting of the production of exactly similar cubic contents in the several cylinders of a multicylinder engine.

In carrying out the invention the valve cylinders are formed in the head of the main cylinder and are axially parallel therewith. They are disposed diametrally opposite from one another and equidisantly from the axis of the main cylinder all in known manner. They are in a plane parallel to the cylinder and at an angle to the crank shaft.

At the inner ends of the valve cylinders are annular inlet and exhaust ports, and the cylinders may be provided with liners.

Within each cylinder is a trunk piston valve, provided with usual piston rings and the inner end of which controls the ports.

The inlet and exhaust piston valves are both operated by cranks, eccentrics, or cams from a single longitudinal overhead shaft.

In order that the invention and the manner of performing the same may be properly understood there are hereunto appended two sheets of explanatory drawings showing an illustrative example of the carrying out of the invention, Figure 1 Sheet 1 being a sectional side elevation, Figures 2 and 3 part sectional plans on the lines *a* and *b* of Figure 1 respectively, while Figure 4 Sheet 2 is a sectional end elevation.

In this example liners A, B in heads of the main cylinders C form the valve cylinders. They are axially parallel with the main cylinder and are diametrally disposed to one another and equidistant from the axis of the main cylinders. They lie in planes inclined to the plane of rotation of the crank shaft D. In the liner-cylinders A, B are respectively annular series of inlet and exhaust ports E, F communicating with inlet and exhaust passages G, H in the main cylinder heads.

Within the liner-cylinders A, B are trunk piston valves J, K provided with usual piston rings and the inner ends of which control the ports E, F.

The inlet and exhaust trunk piston valves J, K are in this instance both operated from a common cranked valve-shaft L by connecting rods M, N. The valve shaft L is carried in bearings P formed for it, half in the lower half R, and half in the upper half S of a valve shaft casing secured upon the main cylinder heads. The valve shaft L is driven by two-to-one chain gearing T from the crank-shaft D.

It is at once apparent that, as has already been said, the whole of the combustion chamber may be machined. Moreover, removal of the piston valves gives very convenient access to the whole of the piston head for the removal of carbon deposits or other operation.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— In an internal combustion engine of the type described, and having valves each of separate trunk-piston form arranged in valve cylinders formed in the main cylinder head and axially parallel with that cylinder, and with each other and the trunk heads of which control inlet and exhaust ports: means for operating the valves comprising a crank or equivalent rotatory shaft axially parallel with the engine crank shaft and connecting rods forming direct operative connection between the cranks or equivalents and the piston valves.

Improvements in Piston-valve Internal Combustion Engines.

—2— The improved valve mechanism for internal combustion engines substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Twenty-eighth day of June, 1912.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

A.D. 1912. JAN. 18. № 1429.

ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

(2 SHEETS)

SHEET 1.

FIG. 1.

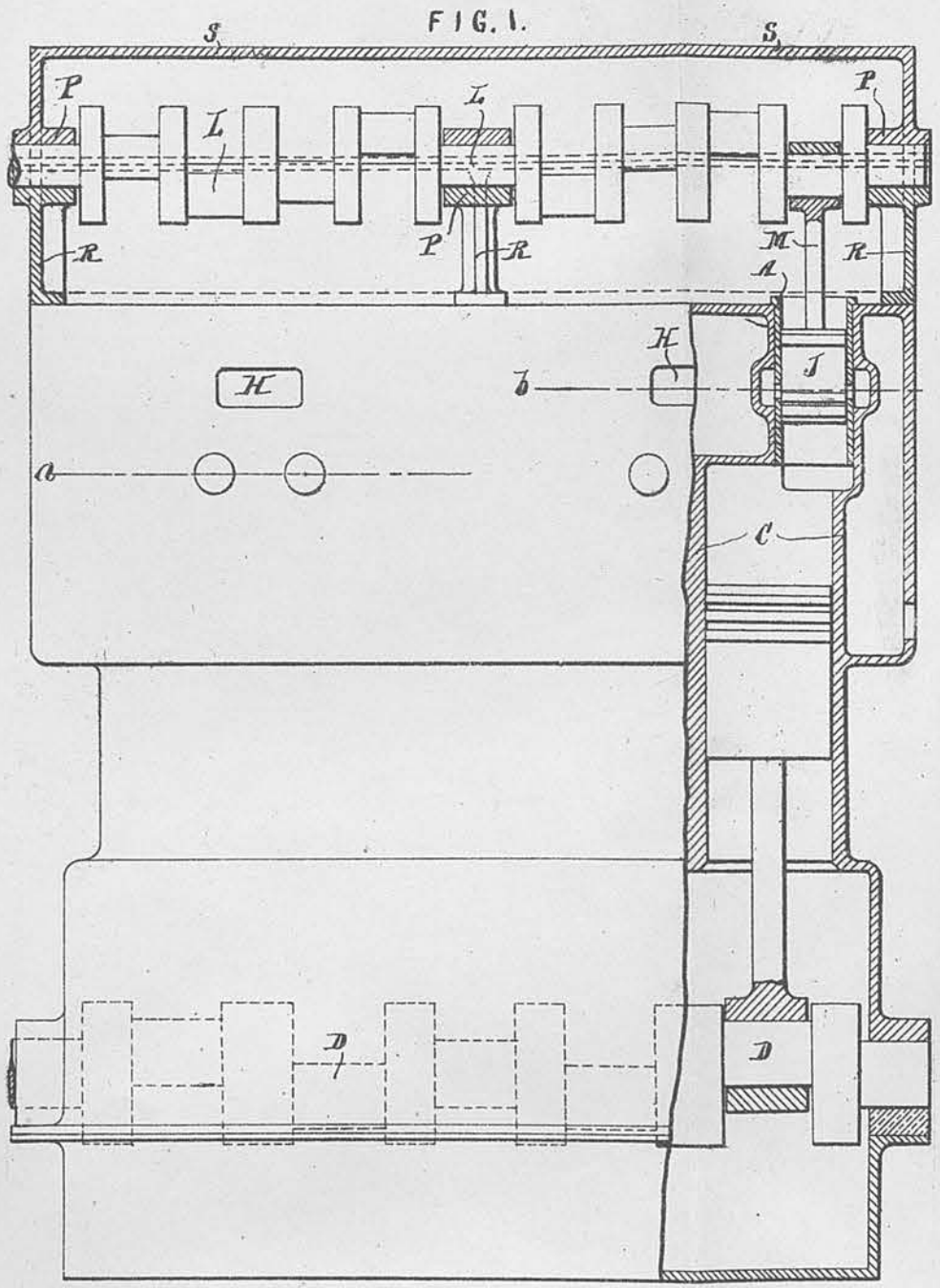


FIG. 2.

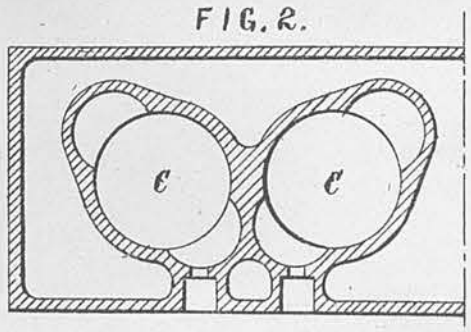
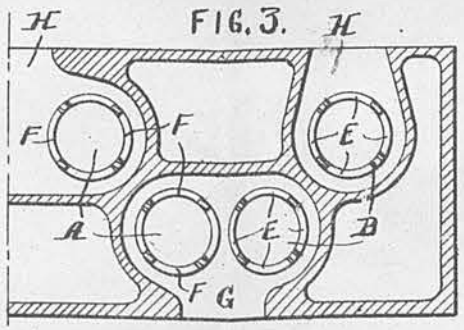
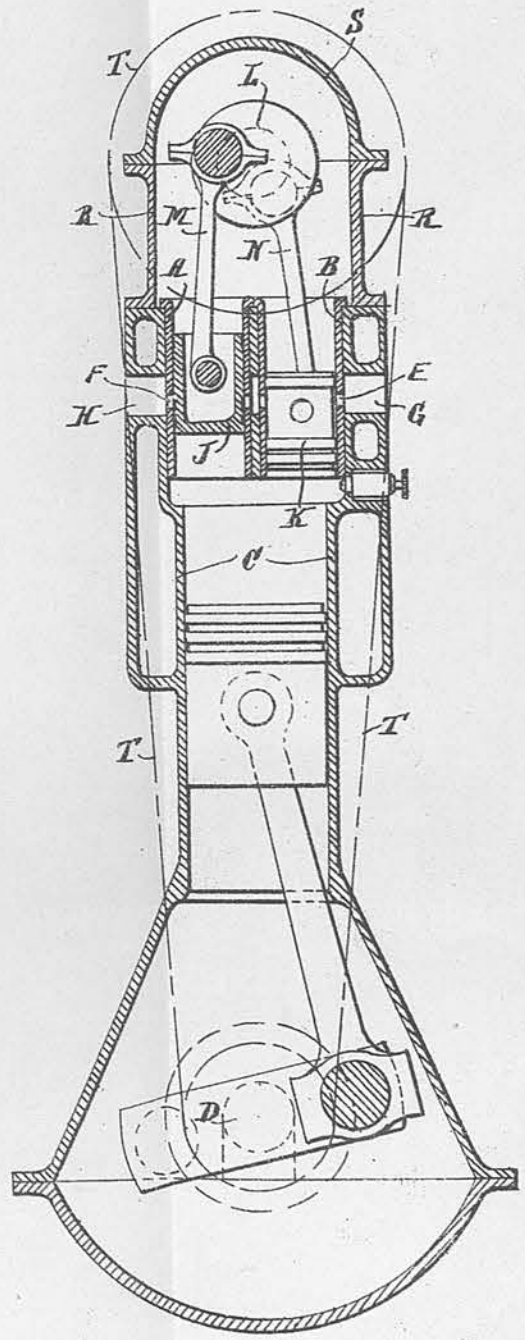


FIG. 3.



SHEET 2.

FIG. 4.



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Malby & Sons, Photo-Litho.

[Second Edition.]

27

N° 15,026 A.D. 1909

Date of Application, 28th June, 1909

Complete Specification Left, 22nd Dec., 1909—Accepted, 23rd June, 1910

PROVISIONAL SPECIFICATION.

Improvements in Two-stroke Cycle Internal-combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to that type of two-stroke cycle internal combustion engine, consisting of unit pairs of cylinders having synchronously moving pistons, in which the combustion spaces of the pairs of cylinders are interconnected, while in one cylinder there is a piston operated port communicating with a closed crank chamber in which is air or explosive mixture, while the other cylinder of the pair has a piston operated exhaust.

The invention has for its object to provide a simple and effective construction of such an engine and combination of unit pairs of cylinders, making for accurate balancing and even turning moment, and rendering it possible to run the engine steadily at a speed more greatly below its normal speed, or at any speed under light load or no load conditions, than hitherto the case with engines of this type.

An engine made according to the invention comprises essentially two or more unit pairs of cylinders in one axial plane and operating one crank shaft. The pistons of each pair are side by side and operate coincident cranks—very conveniently, one crank in each case. The combustion spaces of each unit pair of cylinders are interconnected by a passage, and in one cylinder is a piston operated inlet port connected to the isolated crank chamber of the corresponding crank or pair of cranks, and in the other a piston operated exhaust port.

Where there are two such units in the complete engine, the exhaust ports of each pair may be adjacent to one another and be connected to a common exhaust.

Explosive mixture may be supplied to the pairs of cylinders in any convenient manner usual in engines of this type, and any convenient form of ignition may be used.

The units may be throttle-controlled, but preferably the inlet valves to the isolated crank chambers are mechanically operated, and the units controlled by varying the lift or the period of lift of these valves.

In any case, the control of the throttles or valves, preferably by governor or it might be jointly by hand and governor, is so arranged that the unit pairs are cut out successively. In the case of a four cylinder engine—(this is, two unit pairs) one unit pair may be entirely cut out before the charge to the other unit pair is materially reduced, so that steady running at low speed, or at any speed under light load or no load conditions, is obtained.

The reciprocating and rotating masses of the units may be balanced in known manner, or there may be applied to each unit a dummy piston or sliding weight of commensurate mass operated by a connecting rod from the crank of that unit and moving in an axial plane at right angles to the axial plane of the cylinders.

Dated this Twenty sixth day of June, 1909.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

[Price 8d.]
PRICE 6d.

COMPLETE SPECIFICATION.

Improvements in Two-stroke Cycle Internal-combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to that type of two-stroke cycle internal combustion engine, consisting of unit pairs of cylinders having synchronously moving pistons, in which the combustion spaces of the pairs of cylinders are interconnected, while in one cylinder there is a piston operated port communicating with a closed crank chamber in which is air or explosive mixture, while the other cylinder of the pair has a piston operated exhaust port. It has been proposed to employ more than one unit pair of cylinders in engines of this type; the cylinders of one pair being adjacent and those of the other pair being arranged one on either side of the first pair.

The invention has for its object to provide a simple and effective construction of such an engine and combination of unit pairs of cylinders, making for accurate balancing and even turning moment, and rendering it possible to run the engine steadily at a speed more greatly below its normal speed, or at any speed under light load, or no load conditions, than is hitherto the case with engines of this type.

An engine made according to the invention comprises essentially two or more identical unit pairs of cylinders in one axial plane and operating one crank shaft.

Where there are two such units in the complete engine, the exhaust ports of each pair may be adjacent to one another and be connected to a common exhaust.

Explosive mixture may be supplied to the pairs of cylinders in any convenient manner usual in engines of this type, and any convenient form of ignition may be used.

The units may conveniently be throttle-controlled, by throttling the charge passing from the crank chamber to the cylinders.

In any case, the control of the throttles or valves, preferably by governor, or it might be jointly by hand and governor, is so arranged that the unit pairs are cut out successively. In the case of a four cylinder engine—(that is, two unit pairs) one unit pair may be entirely cut out before the charge to the other unit pair is materially reduced, so that steady running, at low speed or at any speed under light load or no load conditions, is obtained.

The reciprocating and rotating masses of the units may be balanced by the application, in known manner, to each unit, of a dummy piston or sliding weight of commensurate mass operated by a connecting rod from the crank of that unit and moving in an axial plane at right angles to the axial plane of the cylinders.

In order that the invention and the manner of performing the same may be properly understood there are hereunto appended two sheets of explanatory drawings showing in sectional elevation in

Figure 1 an example of a four cylinder engine comprising two unit pairs of cylinders arranged after the manner of the invention,

Figure 2, Sheet 2 being a sectional end elevation of that example, and Figure 3 Sheet 2 a like view of a similar example only modified in so far that there is applied to it the improved balancing arrangement hereinbefore referred to.

In these examples of an engine made according to the invention, there are comprised essentially two (although it might be more than two) unit-pairs A, B, A^1, B^1, of cylinders in one axial plane and operating one crank shaft C which may as shown be in the same plane as the cylinder axes, or may in known manner be set parallel and to one side of that plane. The pairs of pistons A^2, B^2, A^3, B^3, operate each one crank D, D^1, the cranks being at 180° to each other.

The combustion spaces of each pair of cylinders are interconnected by passages E, E^1, and in one cylinder A, B^1 of each pair are piston-operated inlet ports G, G^1 connected to the isolated crank chambers H, H^1 respectively of the two cranks D, D^1 by passages H^2, H^3. In the other cylinders B, A^1 of each pair are similarly operated exhaust ports J, J^1 communicating with a common exhaust trunk J^2.

Explosive mixture is supplied to the two isolated crank chambers H, H^1 through automatic inlet valves K, K^1 drawing their supply from a manifold trunk K^2.

The units are controlled by throttle valves L, L^1 arranged in the passages H^2, H^3 connecting the respective ports G, G^1 to the respective crank chambers H, H^1. The spindles of these valves bear levers and are interconnected by a rod L^2 which may be hand- or governor-operated, or jointly hand and governor operated. In the case of the valve L^1, a spring L^3 is arranged between it and the rod L^2, and it is so set as to cut off before the valve L—the spring L^3 however allowing the latter valve (L) to be closed by continued movement of the rod L^2 after the closing of the valve L^1.

As shown in Figures 1 and 2 the units may be so far balanced in known manner by the application to the crank cheeks of balance weights M, but as shown in Figure 3 more complete balance may be attained by the alternative or additional application of piston-like balance weights N (one for each unit pair) of commensurate mass operated by connecting rods N^1 from the respective cranks of the units and moving in cylindrical guides N^2 in an axial plane at right-angles to the axial plane of the cylinders.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A two-stroke cycle internal-combustion engine comprising two or more unit pairs of interconnected cylinders, each pair being identical, one cylinder of each pair having a piston operated exhaust port and the other a crank-chamber-connected piston-operated inlet port in known manner, the unit pairs operating upon the symmetrically disposed cranks of one crank shaft, as described.

2. In a unit-pair engine of the type forming the subject-matter of Claim 1 hereof, two unit pairs of cylinders operating cranks at 180 degrees to each other and a cylinder of each pair having adjacent exhaust ports connected to a common exhaust.

3. In a unit-pair engine of the type claimed in the foregoing claims hereof, two or more unit pairs with inlet ports connected by passages to corresponding isolated crank chambers and throttle valves in the passages so arranged as to be operated to close or more or less close successively under hand or governor or joint control.

4. A unit pair of cylinders of the type set forth balanced by a dummy piston or weight reciprocated by a connecting rod from the unit-pair crank in a plane at right angles to the axial plane of the cylinders.

5. The unit-pair two-stroke cycle engines substantially as hereinbefore described and as shown in the accompanying drawings.

Dated this Twenty first day of December, 1909.

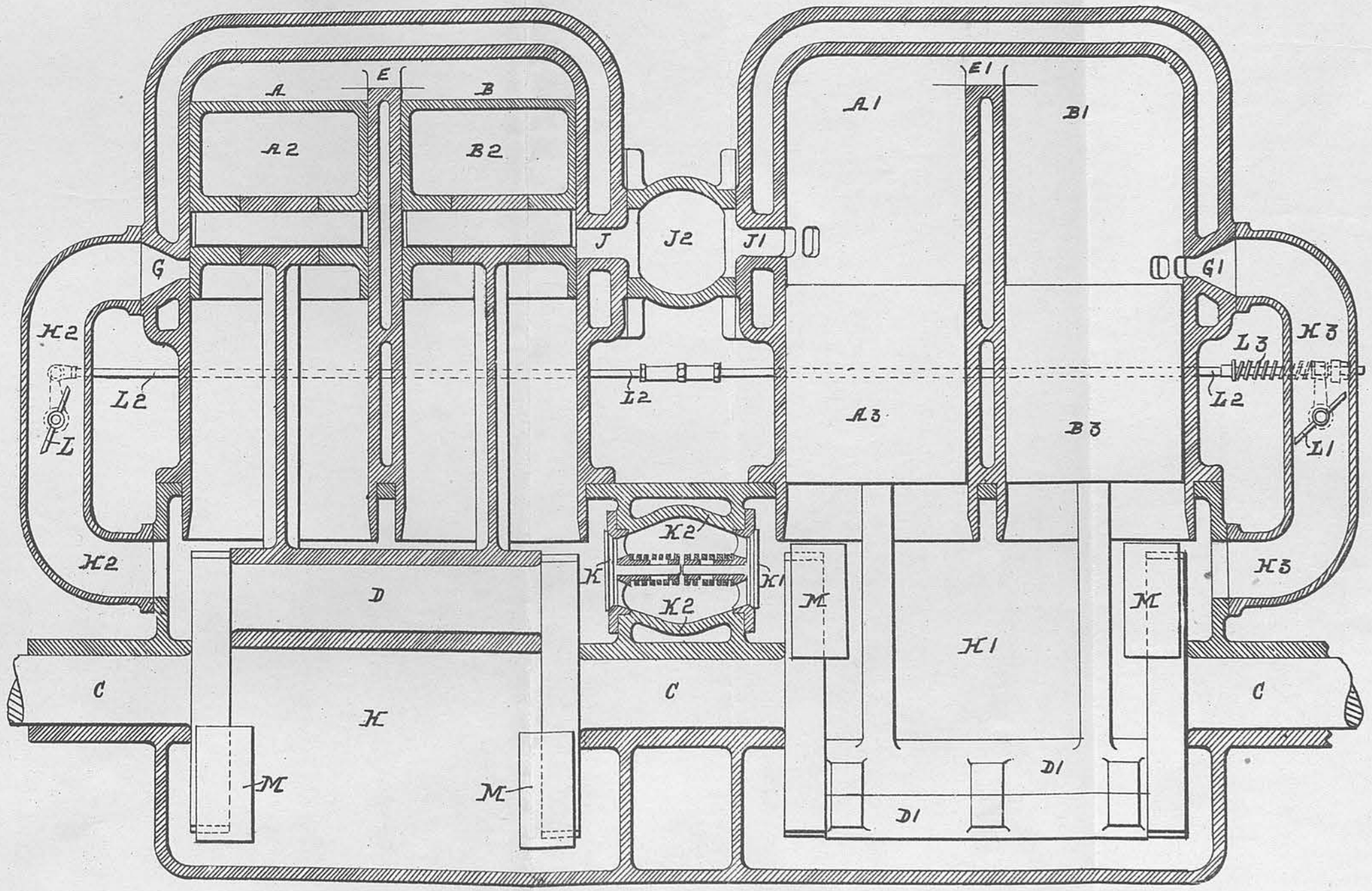
EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 15—50/6/1913.]

(2nd Edition)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.



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(2nd Edition)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 2.

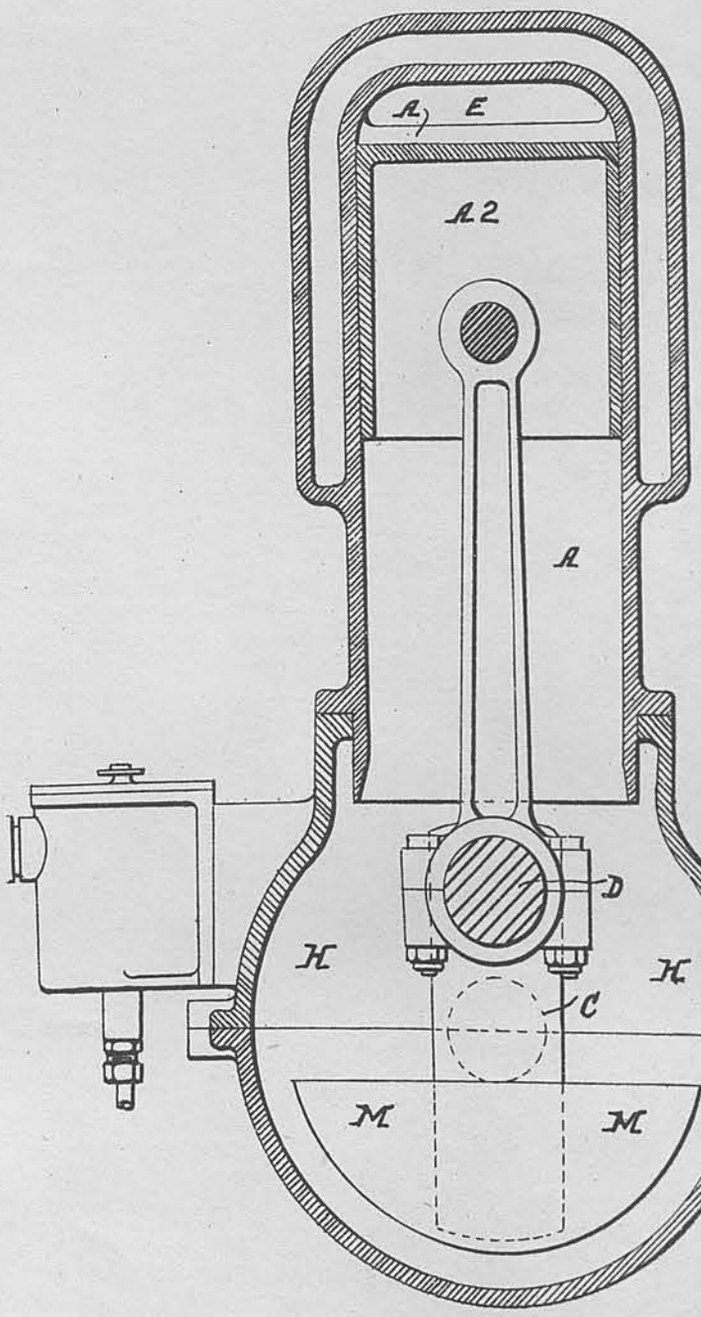
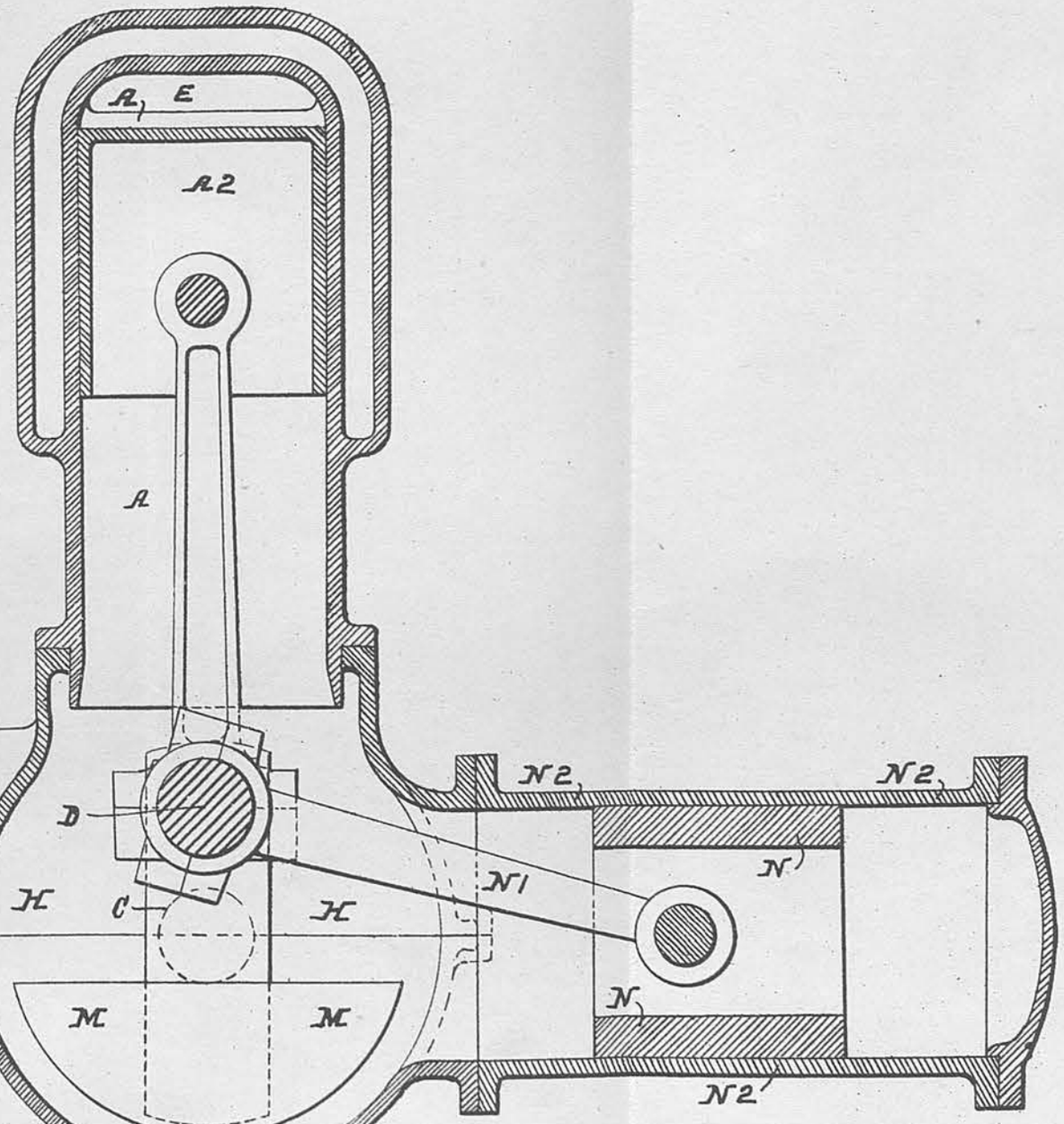


FIG. 3.



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[Second Edition.]

28.

N° 2060 A.D. 1911

Date of Application, No. 2060, 27th Jan., 1911
,, ,, No. 2868, 4th Feb., 1911
Complete Specification Left, 21st July, 1911
(*Section 16 of the Patents and Designs Act, 1907.*)
Complete Specification Accepted, 23rd Nov., 1911

PROVISIONAL SPECIFICATION.

No. 2060, A.D. 1911.

Improvements in Two-stroke Internal-combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention relates to that type of two-stroke internal combustion engines in which there are unit pairs of interconnected cylinders, each pair operating one or coincident cranks, or cranks of small phase difference; and has for its object to provide an improved engine embodying one such unit pair of motor cylinders and two crank-operated fuel or air-and-fuel supplying pumps in such manner that most effective balance of reciprocating and rotary masses is obtained.

In an engine made according to the invention, the pistons of the unit pair of cylinders operate the central crank (or coincident cranks) of a crank shaft, having upon either side of that crank a crank at 180 degrees thereto. These two latter cranks operate single acting pumps, one on either side of the unit pair of cylinders, and the velocities and masses of the reciprocating and rotatory parts of which are jointly equal to those of the unit pair of motor cylinders. Very conveniently, all four pistons and rods—of pumps and of motor cylinders—may be similar, or alternatively, the relative masses may be varied and their velocities varied inversely with the same result. It is to be understood that unit pair and pumps are in axial line.

The pumps may be of any convenient form, but preferably are valveless—that is to say, they are of the piston-uncovered inlet-port type.

Governing by throttle controlling the delivery of the pumps to the motor cylinders is preferably adopted. Each pump preferably has a separate throttle valve operated progressively. That is to say, at full load the pumps operate in parallel to supply the interconnected motor cylinders, while at lighter loads first one pump is throttled and cut out and then the other.

Dated this Twenty sixth day of January, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

PROVISIONAL SPECIFICATION.

No. 2868, A.D. 1911.

Improvements in Two-stroke Internal-combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc.,

[*Price 8d.*]
PRICE 6d.

of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention relates to that type of two-stroke internal combustion engines in which there is a unit pair of interconnected cylinders, the cylinders operating one crank, coincident cranks, or cranks of small phase difference, and has for its object to provide an improved engine embodying such a unit-pair of motor cylinders and two pumps for air and fuel respectively, in such manner that a well-balanced economical and satisfactory engine is produced.

In an engine made according to the invention, the pumps and unit pair lie in one mean plane—that of the crank shaft. The unit pair is between the pumps, and the pump cranks are at 180 degrees or thereby to the crank or cranks of the unit pair. One pump supplies air, the other mixture (compressed as mixture or having fuel added after its compression of air) to that cylinder of the unit pair in which are the piston-uncovered inlet ports.

There are two, or two series of these inlet ports, one or one series uncovered before the other. The air pump delivers air to the port or series of ports first uncovered, the mixture pump to that secondly uncovered. Consequently, when the piston in that cylinder of the unit pair descends, there is first a rush of pure air into it which greatly assists in clearing out the exhaust products, and forms to a certain extent an insulating layer between the hot burnt gases and the in-coming combustible charge which follows on as soon as the piston uncovers the inlet from the cylinder of the unit pair.

When there is no phase difference in the unit pair of motor cylinders, there is probably no phase difference in the pump cylinders, but where there is phase difference in the motor cylinders, there is preferably also phase difference in the pump cylinders. That phase difference may be by inclination of the cylinders, or by crank difference, and for balance all four cylinders or their cranks, as the case may be, may be set alternately to opposite sides of a mean, or again they may be set in adjacent pairs to opposite sides of a mean. In either case the air pump is preferably arranged as of the earlier phase than the mixture pump.

The engine may be conveniently controlled by governor or hand throttling. The throttle valve may be applied either on the inlet or discharge side of the mixture pump, while the inlet to or discharge from the air pump may or may not also be throttle controlled simultaneously. Alternatively, the engine may be controlled by cutting off intermittently in known manner the supply of mixture, or means for the making of mixture from the mixture pump.

Dated this Third day of February, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Two-stroke Internal-combustion Engines.

We, Albion Motor Car Company, Limited, of South Street, Scotstoun, in the County of Renfrew, North Britain, and Thomas Blackwood Murray, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to that type of two-stroke internal combustion engines

in which there are unit pairs of interconnected cylinders, each pair operating one or coincident cranks, or cranks of small phase difference; and has for its object to provide an improved engine embodying one such unit pair of motor cylinders and two crank-operated fuel, air and fuel, or separate air and fuel supplying pumps in such manner that most effective balance of reciprocating and rotatory masses is obtained and a well-balanced economical and satisfactory engine produced.

In an engine made according to the invention, the pistons of the unit pair of cylinders operate the central crank (or coincident cranks) of a crank shaft, having upon either side of that crank a crank at 180 degrees thereto. These two latter cranks operate single acting pumps, one on either side of the unit pair of cylinders, and the velocities and masses of the reciprocating and rotatory parts of which are jointly equal to those of the unit pair of motor cylinders. Very conveniently, all four pistons and rods—of pumps and of motor cylinders—may be similar, or alternatively, the relative masses may be varied and their velocities varied inversely with the same result.

The pumps may be of any convenient form, but preferably are valveless—that is to say, they are of the piston-uncovered inlet-port type.

The pumps may both supply fuel or mixture (air-and-fuel). When they do so, governing by throttle controlling the delivery of the pumps to the motor cylinders is preferably adopted. Each pump preferably has a separate throttle valve operated progressively. That is to say, at full load the pumps operate in parallel to supply the interconnected motor cylinders, while at lighter loads first one pump is throttled and cut out and then the other.

Alternatively, one pump supplies air, the other mixture (compressed as mixture or having fuel added after its compression of air) to that cylinder of the unit pair in which are the piston-uncovered inlet ports.

There are two, or two series of these inlet ports, one or one series uncovered before the other. The air pump delivers air to the port or series of ports first uncovered, the mixture pump to that secondly uncovered. Consequently, when the piston in that cylinder of the unit pair descends, there is first a rush of pure air into it which greatly assists in clearing out the exhaust products, and forms to a certain extent an insulating layer between the hot burnt gases and the in-coming combustible charge which follows on as soon as the piston uncovers the inlet from the cylinder of the unit pair.

When there is no phase difference in the unit pair of motor cylinders, there may be no phase difference in the pump cylinders, but where there is phase difference in the motor cylinders, there is preferably also phase difference in the pump cylinders. That phase difference may be by inclination of the cylinders, or by crank difference, and for balance all four cylinders or their cranks, as the case may be, may be set alternately to opposite sides of a mean, or again they may be set in adjacent pairs to opposite sides of a mean (in either case being of course symmetrically disposed in respect to a mean longitudinal axial plane). In either case the air pump is preferably arranged as of the earlier phase than the mixture pump.

Again, in this form the engine may be conveniently controlled by governor or hand throttling. The throttle valve may be applied either on the inlet or discharge side of the mixture pump, while the inlet to or discharge from the air pump may or may not also be throttle controlled simultaneously. Alternatively, the engine may be controlled by cutting off intermittently in known manner the supply of mixture, or means for the making of mixture from the mixture pump.

In order that the invention and the manner of performing the same may be properly understood, there are hereunto appended four sheets of explanatory drawings illustrating diagrammatically four examples of the carrying out of the invention, Figures 1, 2 and 3, Sheet 1, being, respectively, a sectional side elevation, a sectional end elevation (on line *a*—*a* Figure 3) and a plan of one

example; Figures 4, 5 and 6, Sheet 2, like views of a second example, Figures 7, 8 and 9, Sheet 3, like views of a third example (Figure 8 being a section on the line *b*—*b* of Figure 9) and Figures 10, 11 and 12, Sheet 4, like views of a fourth example (Figure 10 being a section on the line *c*—*c* and Figure 11 on the line *d*—*d* of Figure 12).

In the example shown in Sheet 1 the pistons A B of the unit-pair of cylinders A^1 B^1 operate the central crank C of a crank shaft having on either side of that crank cranks D E at 180 degrees thereto. These two cranks D E operate the pistons of single-acting pumps D^1 E^1. The pistons and rods of the pumps and of the motor cylinders are similar, so are the throws of the respective cranks. Complete longitudinal and rotatory balance is therefore ensured.

The pumps D^1 E^1 are of the piston-uncovered-port type, there being respectively an inlet port D^2 E^2 and an outlet port D^3 E^3 in each cylinder. The connections to and from these ports are not shown in these purely diagrammatic drawings but their arrangement is well understood. Their delivery is preferably governed in the manner already set forth.

In this example, the unit pair of motor cylinders are *en echelon* and the phase-difference indigenous to their type is brought about by their positions relatively to each other and to the crank shaft.

The example shown in Sheet 2 only differs in that the unit pair of motor cylinders A^1 B^1 are in a plane of rotation, and one is directly operated by the crank C, while the other is connected thereto by a connecting rod knuckle joint F. Phase difference between the cylinders is arrived at as in the previous example, while the pumps are similar in themselves and their functions.

The two examples described have been of that form in which the two pumps both supply fuel or mixture (fuel-and-air). The two examples which follow are of that form in which one pump supplies air, the other fuel or mixture. It will be at once apparent that apart from the arrangement of pump ports and their connections the examples are interchangeable for either form—the examples of Sheets 1 and 2 may be modified to the second form about to be described—the examples of Sheets 3 and 4 to the first form just described.

In the example of the second form, shown in Sheet 3, the motor cylinders A^1 B^1 of the unit pair are in line, phase difference being attained by the use of crank pins C^1 C^2 " joggled " to the extent of phase desired.

Instead of the pumps D^1 E^1 both supplying mixture as before, one (D^1) supplies air by way of a port G to the inlet cylinder of the unit pair (exhaust taking place by way of the usual port H in the other cylinder of the pair). The other pump E^1 supplies fuel or mixture by way of a port J. The air port G is slightly in advance so that a charge of scavenging air is sent into the motor cylinder B^1 before fuel reaches it by the port J. Or with similar ports the advance may be by crank phase.

In the second example of the second form, and which is shown in Sheet 4, the motor cylinders A^1 B^1 are *en echelon* and there is a pump (D^1 E^1) in line with each. The ports are arranged as in the example last described.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— A two-stroke internal-combustion engine unit comprising a unit pair of interconnected motor cylinders of known form, and two pumps one on each side thereof, the three units being symmetrically disposed in respect to a mean longitudinal axial plane.

—2— In the engine unit the subject-matter of Claim 1 hereof, pumps supplying jointly fuel or mixture.

—3— In the engine unit forming the subject-matter of the foregoing claims hereof in which two pumps jointly supply fuel or mixture, throttle devices separately and progressively controlling each pump.

—4— In the engine unit the subject-matter of Claim 1 hereof one pump supplying air set as regards its ports or phase to supply scavenging air and the other relatively set to supply fuel or mixture thereafter.

—5— The improved two-stroke internal combustion engine units substantially as hereinbefore described with reference respectively to Sheet 1, to Sheet 2, to Sheet 3, or to Sheet 4 of the accompanying drawings.

Dated this Twentieth day of July, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 35—50/4/1914.]

A.D. 1911. JAN. 27. Nº 2060.

THE ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

(4 SHEETS)

(2nd Edition)

SHEET 1

FIG. 1.

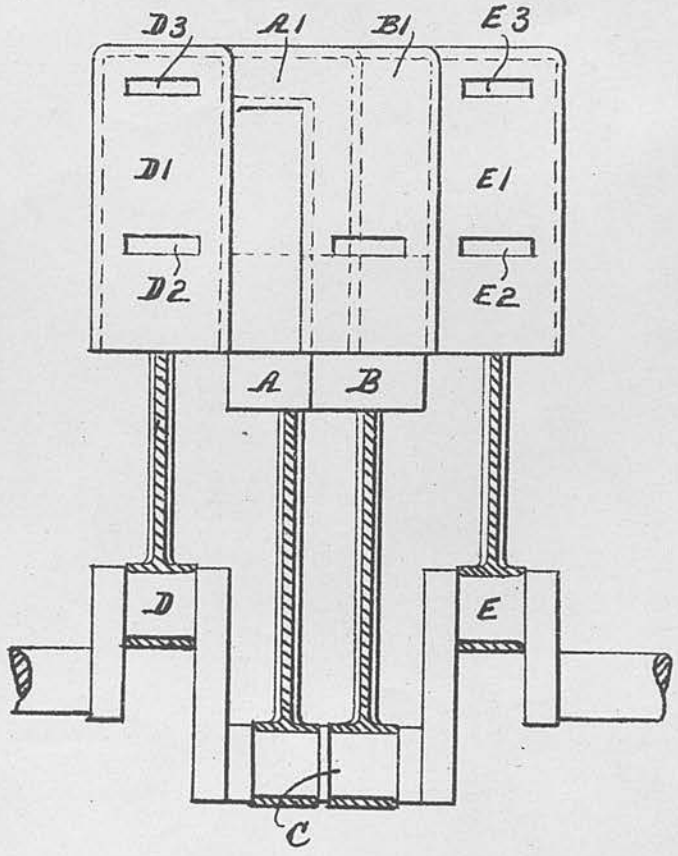


FIG. 2.

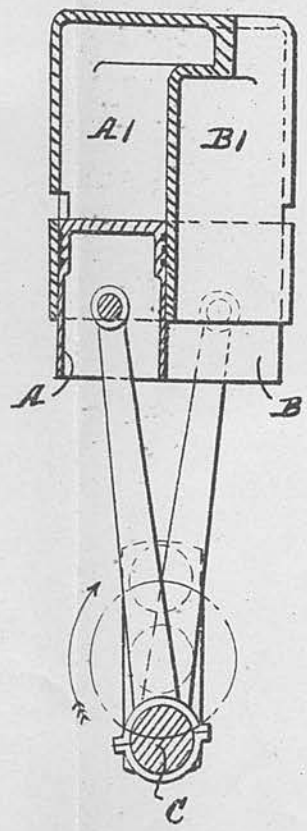
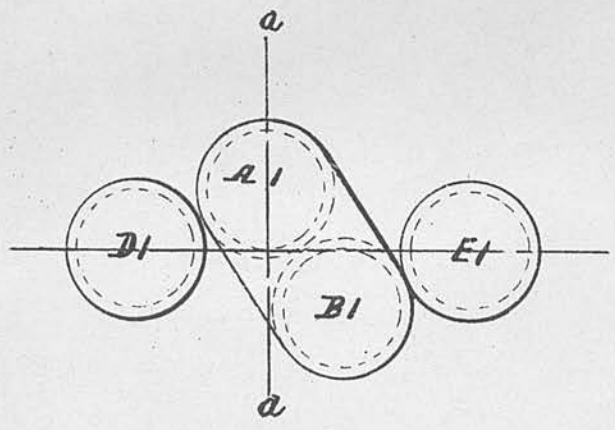


FIG. 3.



SHEET 2

FIG. 4.

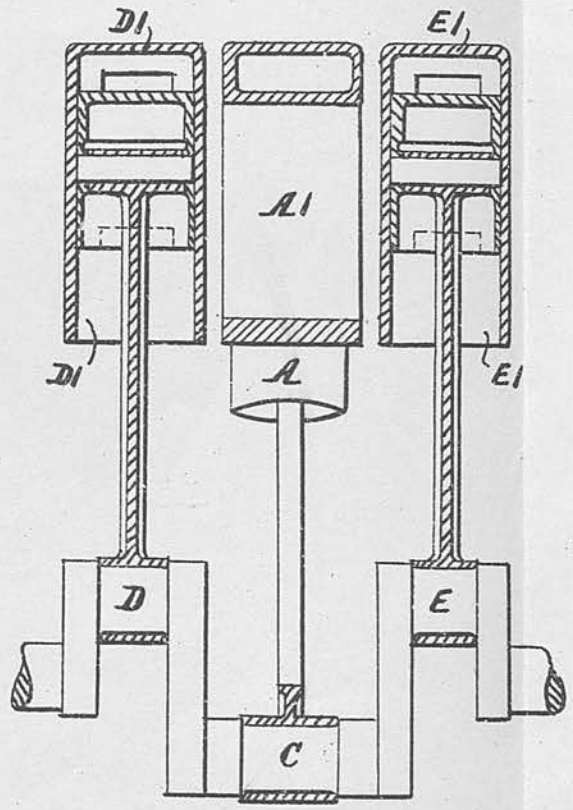


FIG. 5.

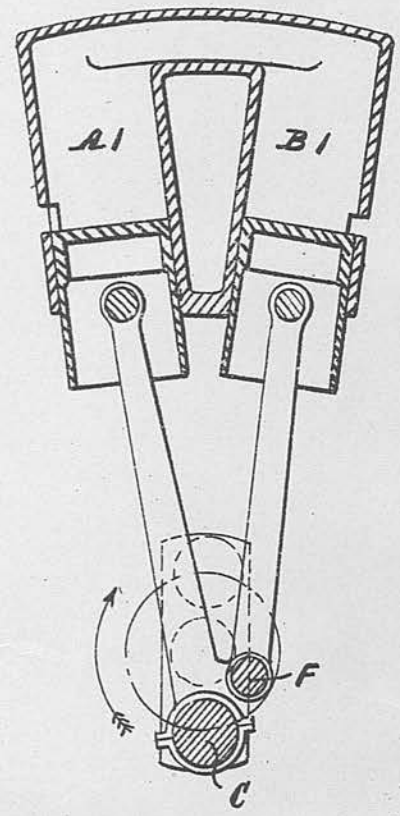
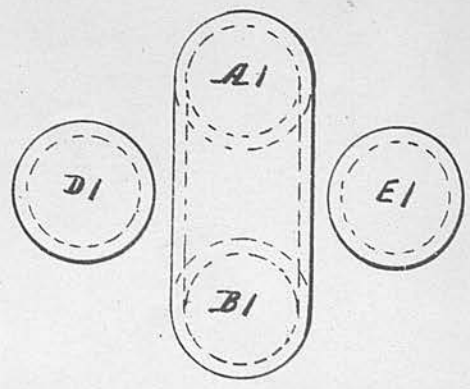


FIG. 6.



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SHEET 3

FIG. 7.

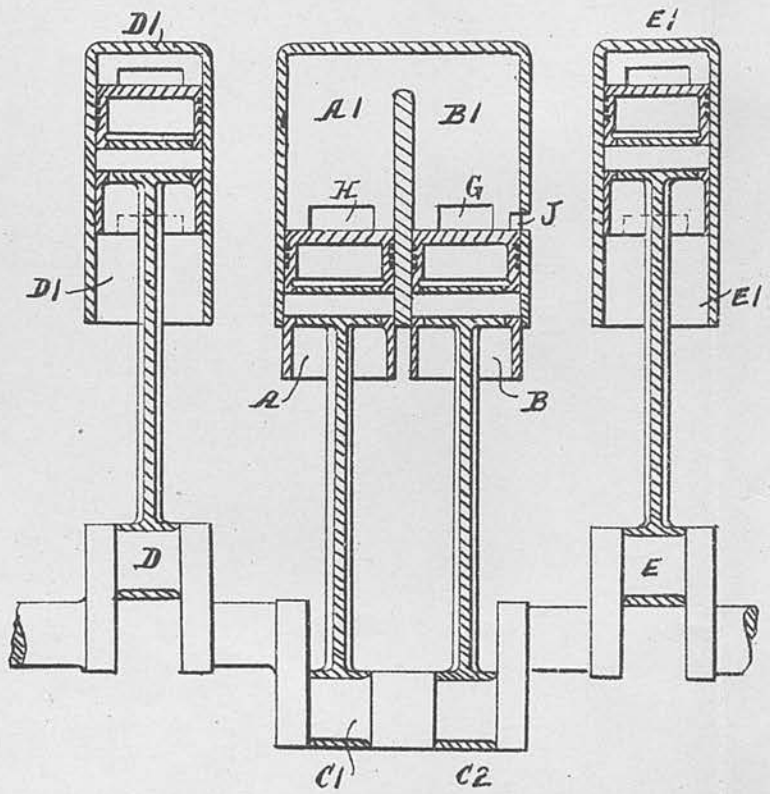


FIG. 8.

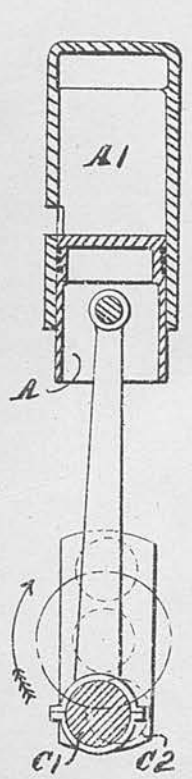
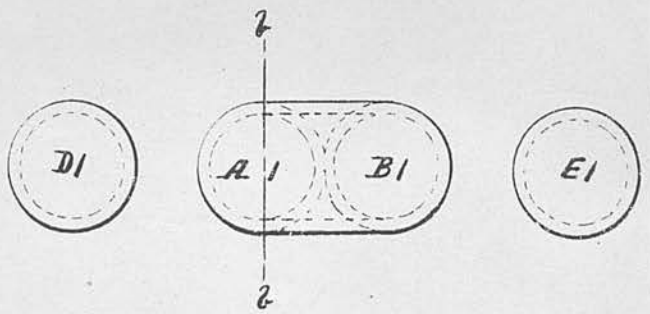


FIG. 9.



SHEET 4.

FIG. 10.

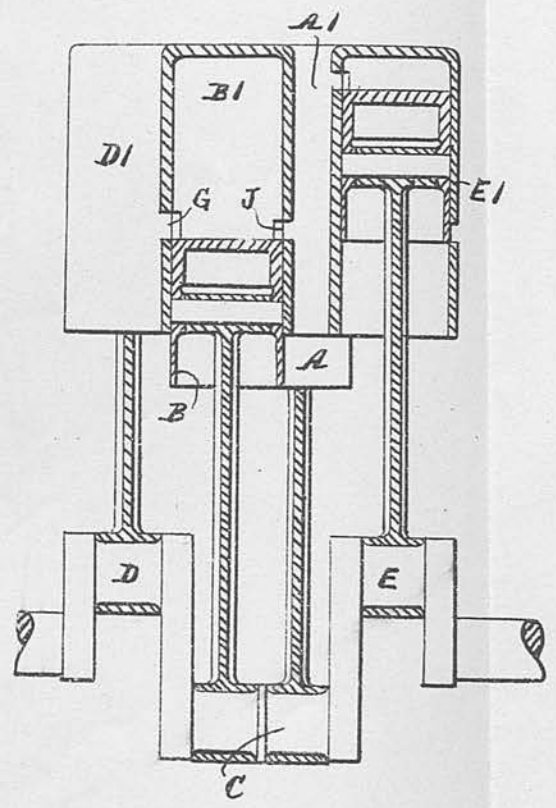


FIG. 11.

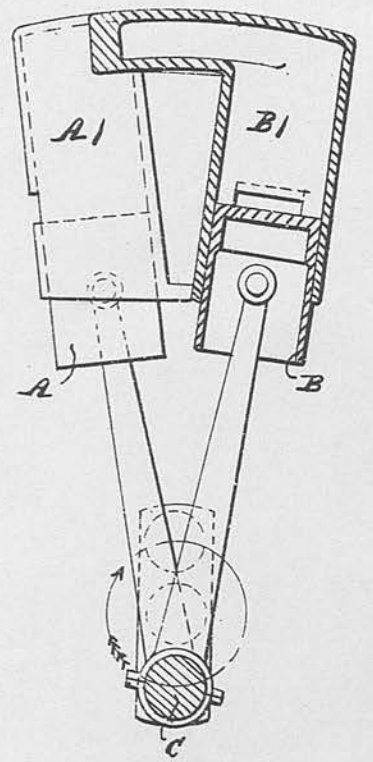
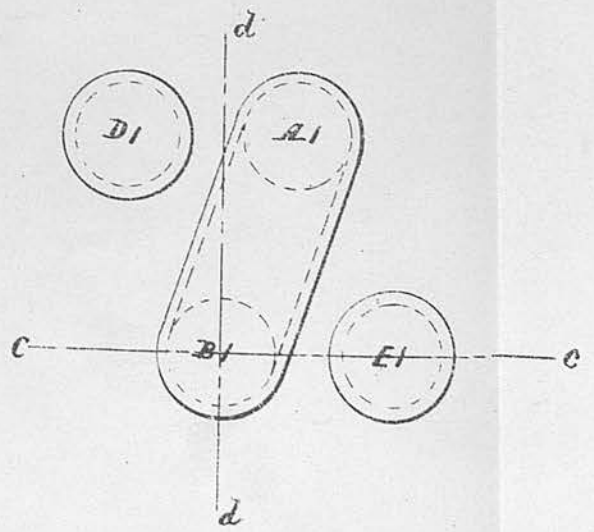


FIG. 12.



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29.

N° 13,915 A.D. 1911

Date of Application, 12th June, 1911

Complete Specification Left, 29th Nov., 1911—Accepted, 22nd Feb., 1912

PROVISIONAL SPECIFICATION.

Improvements in Two-stroke Internal-combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to two-stroke internal-combustion engines of the type in which there are two unit pairs of interconnected cylinders, the cylinders of each pair operating either one crank, coincident cranks, or cranks of small phase difference. The invention has for its object to provide a simple and effective construction of such engines, making for accurate balancing and even turning moment such as is obtained in the ordinary four cylinder motor car engine, the improved construction also giving two equally spaced impulses each revolution when the engine is running at full speed.

An engine made according to the invention comprises essentially two unit pairs of cylinders alternating with two combined air and explosive mixture pumps. The four cranks to which these four units are connected are arranged as usual in a four cylinder engine, that is the first and fourth cranks are approximately coincident with each other and at 180 degrees or thereby to the intervening second and third cranks which are also approximately coincident with each other. The two pumps and the two unit pairs of cylinders lie in one mean plane—that of the crank shaft, the pumps being operated by the first and third cranks, whilst the two unit pairs of cylinders operate the second and fourth cranks, or *vice versa*.

Each of the combined air and explosive mixture pumps comprises a cylinder the bore of which is stepped and in which works a correspondingly stepped piston. The upper portion of each cylinder supplies air, and the lower wider annular portion the explosive mixture; or this arrangement may be reversed with the advantage that any leakage of mixture past the piston whilst it is being compressed in the upper portion would pass into the lower air compressing portion of the cylinder and thus not be lost as it would pass with the air, as hereinafter described, into the unit pair of cylinders.

Each of the unit pair of operating cylinders is constructed as described in our earlier Patent Specification No. 2868 of 1911. That is in one cylinder of each unit pair there are two, or two series of, piston-uncovered inlet ports, one or one series being uncovered before the other. In the other cylinder of each unit pair is the piston-uncovered exhaust port.

The air compressor part of one pump is connected to the port or series of ports first uncovered in the cylinder of one unit pair of cylinders, the same part of the other pump being connected to the similar port or ports in the same cylinder of the other unit pair. Similarly the explosive mixture compressor parts of the two pumps are connected to the secondly uncovered ports in these two cylinders. Air is therefore first delivered to these cylinders before the explosive mixture is allowed to enter, with the advantage stated in the earlier specification hereinbefore referred to; and as the cranks of the two pumps and of the two unit pairs of operative cylinders are arranged relatively to each

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PRICE 6d.

other as hereinbefore described, the charge is so supplied to the operative cylinders that two equally spaced impulses for each revolution are obtained.

For the purpose of balance it is essential that the reciprocating and rotating masses should be suitably proportioned. If the throws of all four cranks are equal, then similar total masses should be operated by each crank and the weight of the stepped piston in each pump should equal the combined weight of the two pistons in one unit working pair. Similarly the mass of the connecting rod for each pump should equal the combined masses of the two connecting rods of one unit-pair.

The governing of the engine at less than full load may be carried out in a similar manner to that described in our earlier patent specification hereinbefore referred to, or for the purposes of economy it may be governed by entirely cutting out of action one of the unit pairs; or by reducing the charge to one in a greater degree than to the other as described for instance in our prior Specification No. 15,026 of 1909, or by any combination of these methods.

Dated this Tenth day of June, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Two-stroke Internal-combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to two-stroke internal-combustion engines of the type in which there are two unit pairs of interconnected cylinders, the pistons of each pair moving with a small phase difference and operating either one crank, coincident cranks, or cranks of small phase difference, and served by pumps operated from the crank shaft.

The invention has for its object to provide a simple and effective construction of such engines, making for accurate balancing and even turning moment such as is obtained in the ordinary four cylinder motor car engine, the improved construction also giving two equally spaced impulses each revolution when the engine is running at full load.

An engine made according to the invention comprises essentially two unit pairs of cylinders alternating with two combined air and explosive mixture pumps. The four cranks to which these four units are connected are arranged as usual in a four cylinder engine, that is the first and fourth cranks are approximately coincident with each other and at 180 degrees or thereby to the intervening second and third cranks which are also approximately coincident with each other. The two pumps and the two unit pairs of cylinders lie in or are symmetrically disposed in respect to one mean longitudinal axial plane—that of the crank shaft—the pumps being operated by the first and third cranks, whilst the two unit pairs of cylinders operate the second and fourth cranks, or *vice versa* all in known manner.

Each of the combined air and explosive mixture pumps comprises a cylinder, the bore of which is stepped and in which works a correspondingly stepped piston. The upper portion of each cylinder supplies air, and the lower wider

annular portion the explosive mixture; or this arrangement may be reversed with the advantage that any leakage of mixture past the piston whilst it is being compressed in the upper portion would pass into the lower air compressing portion of the cylinder and thus not be lost as it would pass with the air, as hereinafter described, into the unit pair of cylinders.

For the purpose of balance it is essential that the reciprocating and rotating masses should be suitably proportioned. If the throws of all four cranks are equal, then similar total masses should be operated by each crank, and the weight of the stepped piston in each pump should equal the combined weight of the two pistons in one unit working pair. Similarly the mass of the connecting rod for each pump should equal the combined masses of the two connecting rods of one unit-pair.

The governing of the engine at less than full load may be carried out in a similar manner to that described in our earlier Patent Specification, No. 2060, of 1911, or for the purposes of economy it may be governed by entirely cutting out of action one of the unit pairs; or by reducing the charge to one in a greater degree than to the other, or by any combination of these methods.

There are illustrated diagramatically, on two accompanying sheets of explanatory drawings two examples of the improved engine differing only in the known arrangements of unit-pair cylinders embodied in them. Figures 1, 2 and 3, Sheet 1, are respectively a sectional side elevation, a plan and a sectional end elevation of one example, while Figures 4, 5 and 6, Sheet 2, are like views of the other example.

It is, of course, clear that the invention lies not in the form of the unit-pair cylinders or their precise means of operation, but in their particular combination with particular forms of pump, and therefore, any of those alternative forms of unit-pairs of cylinders made known for example by our prior specification first hereinbefore referred to may be substituted for those shown by way of example.

In the example shown in Figures 1, 2 and 3, the two unit-pairs, A B, C D, of cylinders are arranged en echelon relatively to the crank shaft E, and by this means the well known phase difference in the movements of each pair of pistons is attained.

The pistons of one unit-pair, A B, of cylinders operate a crank F, at 180 degrees to the crank G, operated by the other unit-pair C D.

The combined air and mixture pumps alternate in axial line with the cylinder units, and each comprises a pump cylinder H, the bore of which is stepped, the plunger J, being correspondingly stepped. Either the upper portion may supply mixture, and the lower annular portion air, or *vice versa*, preferably the former, for the reasons already set forth.

The plungers of the pumps are operated by cranks at 180 degrees to each other, and to those unit-pairs, to which they are adjacent.

Each of the unit-pairs, A B, C D, of operating cylinders is provided with ports, as described in our earlier Patent Specification No. 2060 of 1911. That is, in one cylinder of each unit pair there are two, or two series of, piston-uncovered inlet ports, one or one series being uncovered before the other. In the other cylinder of each unit pair is the piston-uncovered exhaust port.

The air compressor part of one pump is connected to the port or series of ports first uncovered in the cylinder of one unit pair of cylinders, the same part of the other pump being connected to the similar port or ports in the same cylinder of the other unit pair. Similarly the explosive mixture compressor parts of the two pumps are connected to the secondly uncovered ports in these two cylinders. Air is therefore first delivered to these cylinders before the explosive mixture is allowed to enter, with the advantage stated in the earlier specification hereinbefore referred to, and as the cranks of the two pumps and of the two unit pairs of operative cylinders are arranged relatively to each

other as hereinbefore described, the charge is so supplied to the operative cylinders that two equally spaced impulses for each revolution are obtained.

The example shown in Figures 4, 5 and 6, only differs from that described, in that the cylinders of each unit pair A B, C D, are in axial line—piston phase difference being arrived at by slightly staggering the cranks F, F^1, G, G^1, of each pair relatively to one another.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

—1— In an engine comprising a plurality of unit pairs of cylinders, lying in or symmetrically disposed in respect to a mean longitudinal axial plane, and served by pumps alternating with each unit pair, all in known manner; stepped cylinder air-and-mixture pumps in the same mean axial plane, the cranks of the pumps and of each adjacent unit pair of cylinders being at 180 degrees to each other, as and for the purposes set forth.

—2— The improved two-stroke internal combustion engine substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Twenty-eighth day of November, 1911.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

A.D. 1911. JUNE 12 № 13,915.

ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

(2 SHEETS)

SHEET 1.

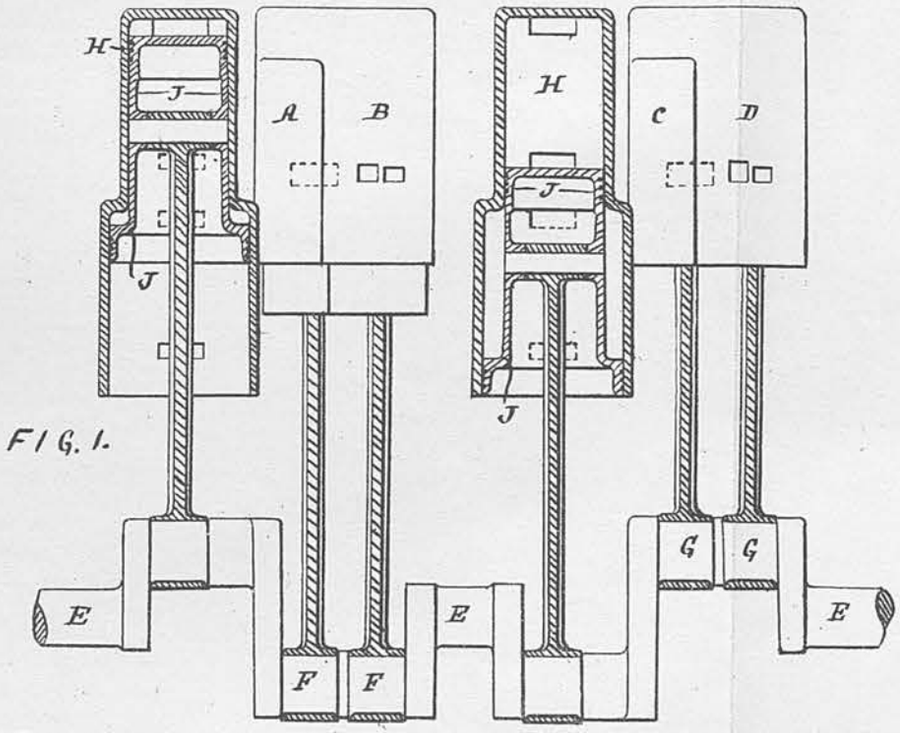


FIG. 1.

FIG 2.

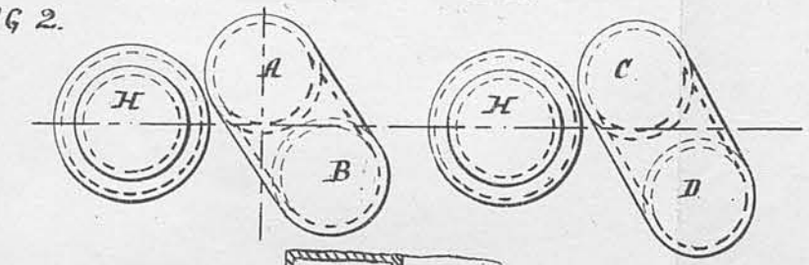
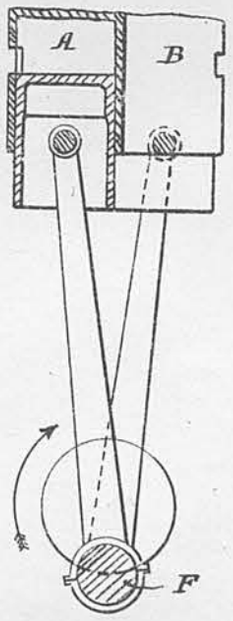


FIG. 3.



SHEET 2.

FIG. 4.

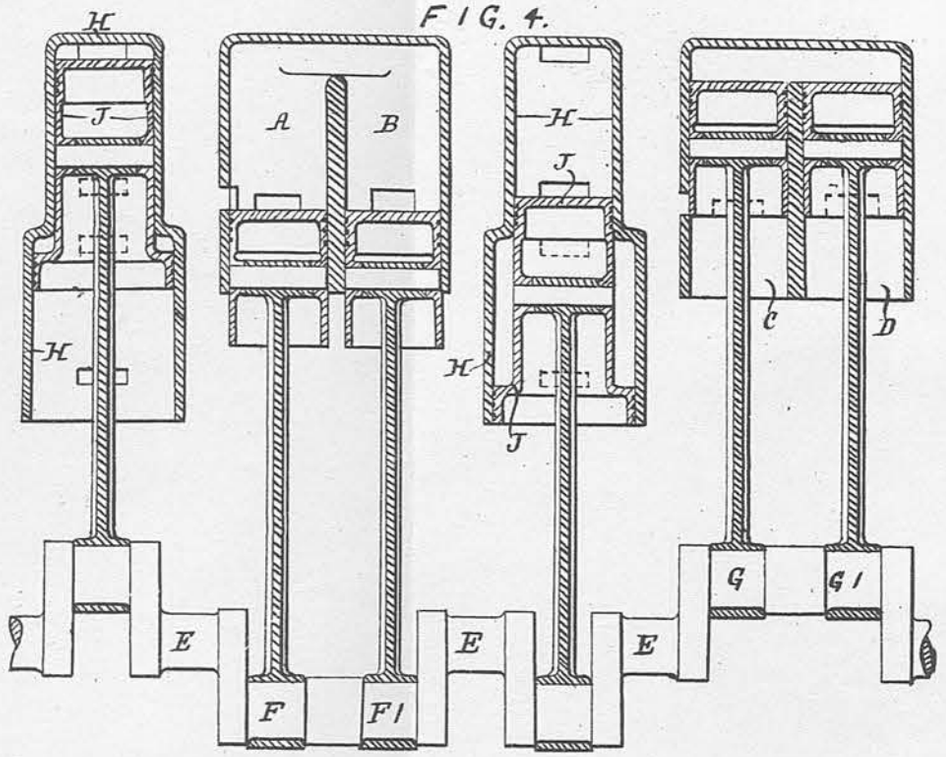


FIG. 5.

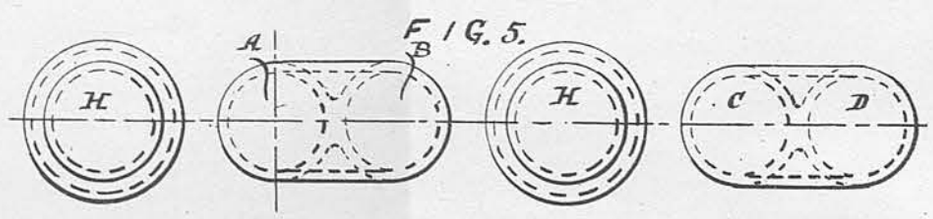
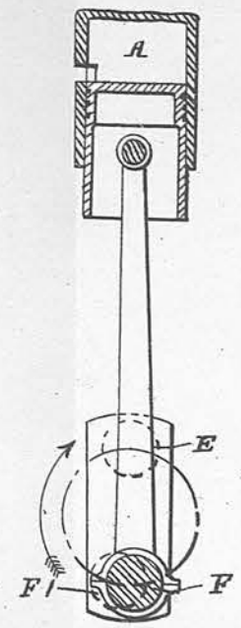


FIG. 6.



[This Drawing is a reproduction of the Original on a reduced scale.]

Malby & Sons, Photo-Litho.

30.

N° 2252 A.D. 1914

Date of Application, 28th Jan., 1914

Complete Specification Left, 10th July, 1914—Accepted, 7th Jan., 1915

PROVISIONAL SPECIFICATION.

An Improved Two-stroke Cycle Internal Combustion Engine.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention has for its object to provide a six-cylinder engine of two stroke cycle in which three of the cylinders are working cylinders and three pump cylinders, in which the rotational balance is practically complete, and in which, while a vacuum adequate for the effective induction of the charge is obtained in the pump cylinders, the pressure of subsequent compression there is not so great that when the charges commence to pass to the working cylinders any considerable part reaches and passes out through the then open exhaust ports in those cylinders.

In an engine made according to the invention the cylinders are in or substantially in one longitudinal plane, and are alternately pump and working cylinders—each pump cylinder serving its neighbouring working cylinder.

A passage connects each pump cylinder with the usual piston-controlled inlet port in the working cylinder it feeds. Communication between this passage and the pump cylinder is controlled by an outwardly-opening automatic valve. This valve is so placed and the pump cylinder head is so formed that clearance there is small. The passage between the pump cylinder and its working cylinder is of such volume as to give the most effective compression pressure to the mixture. Thus, there being little clearance between the pump piston and cylinder head, high vacuum giving adequate induction is attained. At the same time compression pressure can never exceed that determined by the volume of the passage, thus it may be arranged that mixture does not appreciably escape by the working cylinder exhaust port. In order to further secure this and to attain effective scavenging, the piston-uncovered inlet port of each working cylinder is of such form that the first part of the entering mixture is directed up close to the cylinder wall, which effect is further assisted by a conchoidal baffle on the piston head adapted also to similarly direct the entering mixture.

The pump inlet ports, to which is connected a carburettor of any convenient form, may be controlled by the moving pump pistons, or by automatic or mechanically operated valves.

When the passage between pump cylinders and working cylinders is thus controlled by a valve, it is apparent that these cylinders may operate in practically any phase relatively to one another. Thus the crank shaft of six throws may have its cranks in pairs at 120 degrees to one another—the central pair of cranks coincident, the next pair of cranks adjacent thereto coincident, and the outer pair again coincident.

It will be observed, however, that in one of the end pairs of cylinders the pump crank is 120 degrees in advance of the crank of the working cylinder it

feeds. Thus the inlet to that working cylinder is opened after the pump compression stroke has begun, and closed before that stroke is finished. Therefore if it is desired that there be a certain definite pressure in the connecting passage at the moment the inlet port is uncovered, this particular passage must be of considerably smaller volume than the two others. Further, since the terminal pressure in this pump cylinder is lower, it may be necessary that it have a clearance volume less than that of the other pump cylinders.

Means are preferably provided for successively cutting out and letting in the units under varying loads.

Dated this Twenty-seventh day of January, 1914.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

An Improved Two-stroke Cycle Internal Combustion Engine.

We, Albion Motor Car Company, Limited, of South Street, Scotstoun, in the County of Renfrew, North Britain, and Thomas Blackwood Murray, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to two-stroke cycle internal combustion engines of the pump-fed type, and has for its object to provide a six-cylinder engine of two stroke cycle in which three of the cylinders are working cylinders and three pump cylinders, in which the rotational balance is practically complete, and in which, while a vacuum adequate for the effective induction of the charge is obtained in the pump cylinders, the pressure of subsequent compression there is not so great that when the charges commence to pass to the working cylinders any considerable part reaches and passes out through the then open exhaust ports in those cylinders.

In an engine made according to the invention the cylinders are in or substantially in one longitudinal plane, and are alternately pump and working cylinders—each pump cylinder serving its neighbouring working cylinder.

A passage connects each pump cylinder with the usual piston-controlled inlet port in the working cylinder it feeds. Communication between this passage and the pump cylinder is controlled by an outwardly-opening automatic valve. This valve is so placed and the pump cylinder head is so formed that clearance there is small. The passage between the pump cylinder and its working cylinder is of such volume as to give the most effective compression pressure to the mixture. Thus, there being little clearance between the pump piston and cylinder head, high vacuum giving adequate induction is attained. At the same time, compression pressure can never exceed that determined by the volume of the passage, thus it may be arranged that mixture does not appreciably escape by the working cylinder exhaust port. In order to further secure this and to attain effective scavenging, the piston-uncovered inlet port of each working cylinder is of such form that the first part of the entering mixture is directed up close to the cylinder wall, which effect is further assisted by a conchoidal baffle on the piston head adapted also to similarly direct the entering mixture.

The pump inlet ports, to which is connected a carburettor of any convenient

form, may be controlled by the moving pump pistons, or by automatic or mechanically operated valves.

When the passage between pump cylinders and working cylinders is thus controlled by a valve, it is apparent that these cylinders may operate in practically any phase relatively to one another. Thus the crank shaft of six throws may have its cranks in pairs at 120 degrees to one another—the central pair of cranks coincident, the next pair of cranks adjacent thereto coincident, and the outer pair again coincident.

It will be observed, however, that in one of the end pairs of cylinders the pump crank is 120 degrees in advance of the crank of the working cylinder it feeds. Thus the inlet to that working cylinder is opened after the pump compression stroke has begun, and closed before that stroke is finished. Therefore if it is desired that there be a certain definite pressure in the connecting passage at the moment the inlet port is uncovered, this particular passage must be of considerably smaller volume than the two others. Further, since the terminal pressure in this pump cylinder is lower, it may be necessary that it have a clearance volume less than that of the other pump cylinders.

Means are preferably provided for successively cutting out and letting in the units under varying loads.

A six-crank engine made according to the invention is shown in sectional elevation in Figure 1 on an accompanying sheet of explanatory drawings, while in Figure 2 is shown an end view of its crank shaft.

In this engine there are three units consisting of pump cylinders and working cylinders A, B, C, D, H, J. These operate the cranks A^1, B^1, C^1, D^1, H^1, J^1 of a six-throw crank shaft. These cranks are arranged as is more clearly seen in Figure 2, (a view from the left hand of Figure 1) and it will be observed, as already stated, that in the end pair of cylinders H, J, the pump crank H^1 is 120 degrees in advance of the corresponding working cylinder, thus the piston controlled inlet to that cylinder is uncovered after the pump compression stroke has begun, and almost closed before that stroke is finished. Therefore if it is desired that there be a certain definite pressure in the connecting passage K at the moment the inlet port is uncovered, this particular passage must be of considerably smaller volume than the two others E, G. Further, since the terminal pressure in this pump cylinder is lower, it may be necessary that it have a clearance volume less than that of the other pump cylinders.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

A two stroke cycle internal combustion engine of the type set forth and comprising three pump cylinder and working cylinder units operatively connected to a six-throw crank-shaft with cranks at 120 degrees to one another for the purpose set forth, the passage connecting that working cylinder with its pump cylinder which is 120 degrees in advance being of lesser volume than the volumes of the two other passages as set forth.

Dated this Ninth day of July, 1914.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.

FIG. 1.

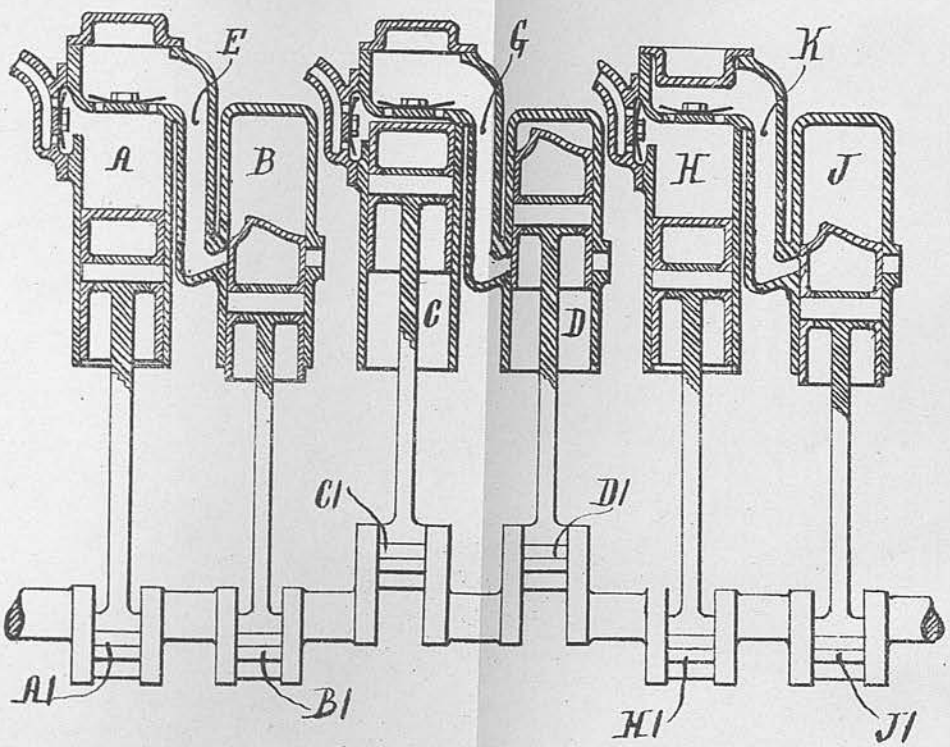
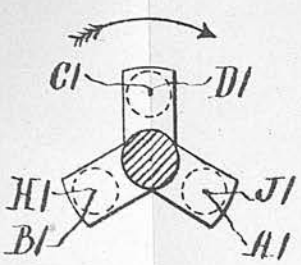


FIG. 2.



[This Drawing is a reproduction of the Original on a reduced scale]

Malby & Sons, Photo-Litho.

31.

N° 19,151 A.D. 1909

Date of Application, 20th Aug., 1909—Accepted, 27th Jan., 1910

COMPLETE SPECIFICATION.

"Improved Means for Driving Cam-shafts and the like in Internal Combustion Engines."

We, ALBION MOTOR CAR COMPANY LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

In multi-cylinder internal combustion engines, such as are used in motor cars, the cam shaft or shafts is usually driven through gearing from a pinion keyed or otherwise rigidly secured on the crank shaft, the cam shaft or shafts in turn driving through gearing the magneto, pump, governor, or other subsidiary mechanism of the engine.

As the flywheel is usually at one end of the crank shaft and the gearing referred to at the other end thereof, when explosion takes place, especially in the cylinder which is remote from the flywheel, there is quite an appreciable rotary spring or torsion of the crank shaft. This torsion causes a periodic knock or blow between the teeth of the gearing and thereby produces quite an appreciable and objectionable noise.

To overcome this objection, it has been proposed, according to one method, to carry the pinion loose on the shaft and drive it through the medium of a spring, but this spring has either been so arranged that it only acts in one direction, that is, to transmit motion from the shaft to the pinion, and not also to slowly arrest the continued movement of the pinion in the event of the slowing of the shaft; or has been a spiral spring of many convolutions, and for this reason has not acted effectively in both directions.

According to a further construction a rubber coupling has been proposed to be used, but this arrangement lacks the necessary amplitude of movement, and is liable to rapid deterioration.

The present invention has for its object to provide an improved and simple arrangement of spring drive for the pinion, whereby the necessary cushioning effect between the crank shaft and the pinion is effected and the torsion or sudden rotary acceleration of part of the shaft hereinbefore described thus taken up, thereby preventing the knock or blow between the teeth of the gearing and consequently eliminating the noise, the spring drive being also so arranged that it arrests the continued movement of the pinion on slowing of the shaft.

In order that the invention and the manner of performing the same may be properly understood, there is hereunto appended a sheet of explanatory drawings in which

Figure 1 is a longitudinal section of part of a crank shaft sufficient to show an example of the improved flexible connection between that shaft and the pinion rotated thereby;

Figures 2, 3, and 4 being respectively transverse sections on the lines *a*—*b*, *c*—*d*, and *e*—*f*, Figure 1.

As shown in the drawings the pinion A is mounted upon a long bush B which is free to rotate on a parallel portion of the front end of the crank shaft C. The bush B is prevented from moving endwise on the crank shaft C by being held between a shoulder D on the shaft and a

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PRICE 6d.

collar E fixed rigidly on the shaft near its outer end. This collar E is internally bored taper to fit a corresponding taper on the crank shaft C, and it is secured in position by means of a feather G, so that it rotates with the shaft. The collar E is held in position and prevented from moving endwise off the shaft C by means of a nut H screwed on the shaft and held in turn by a split pin J. At a suitable radial distance an aperture K is bored in the boss N of the pinion A parallel to its axis and a similar aperture L in a similar position in the collar E. In these two apertures the ends of a spiral spring M engage, this spring consisting of a band of flat steel passed once round the shaft. The ends are turned parallel to the axis of the shaft, in line with each other and of circular section an exact fit for the apertures in the pinion and collar respectively. This spring M forms a flexible driving member between the collar E rigidly secured on the crank shaft C and the pinion A; and its elasticity is such that it permits of the slight rotation of the bush and pinion relatively to the crank shaft to compensate for the sudden torsion of the crank shaft hereinbefore described as taking place when explosion is effected especially in the cylinder farthest from the flywheel, the spring also acting to arrest the movement of the pinion without jarring contact with any stop when slowing of the shaft takes place.

If desired a similar flexible driving connection may be interposed between other shafts in the engine and the gearing driven therefrom so as to compensate for any sudden torsion which may be imparted to such shafts and thereby lessen the possibility of an objectionable noise being caused in the working of such gearing. For example, it may be interposed between the cam shaft or shafts and the gearing driven therefrom to actuate the subsidiary mechanism of the engine.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In an internal combustion engine of the type in which mechanism is driven through gearing from a pinion (or pinions) on a shaft (or shafts) of the engine and having a flexible driving connection between the shaft (or shafts) and the pinion (or pinions) operated thereby, a pinion mounted on a bush free to rotate but not move endwise on a shaft, a collar secured rigidly on the shaft and a flat spiral spring of one convolution with its ends adjacent and having formed on it cylindrical pins normally in line, parallel with the axis of the shaft, extending laterally in opposite directions and engaging counterpart apertures in the pinion and collar on the shaft respectively.

2. Improved means for driving cam shafts and the like in internal combustion engines substantially as hereinbefore described and as shown in the accompanying drawings.

Dated this Nineteenth day of August, 1909.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1910.

A.D. 1909. Aug. 20. No. 19,151.

THE ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

(1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

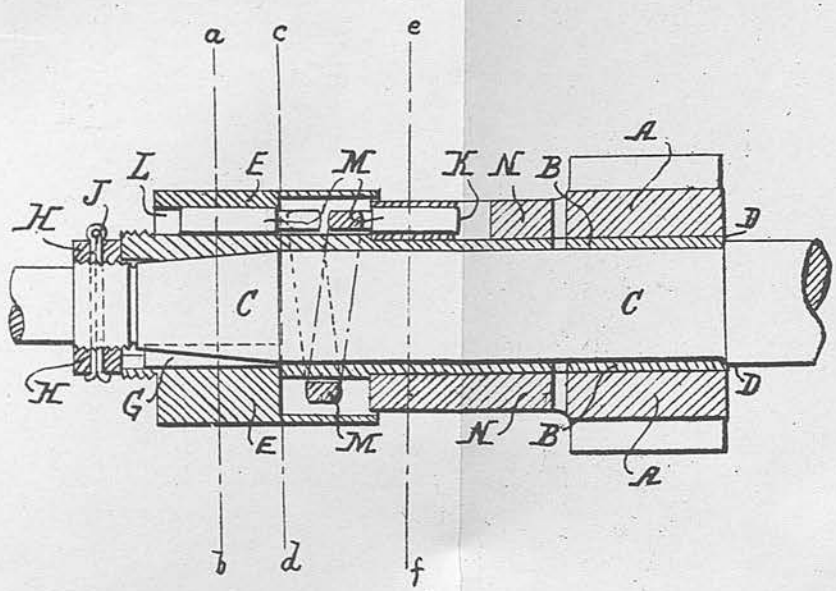


FIG. 2.

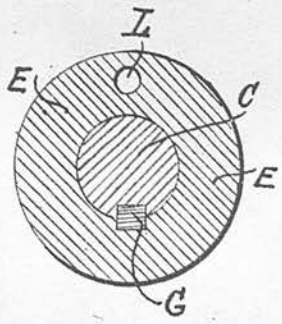


FIG. 3.

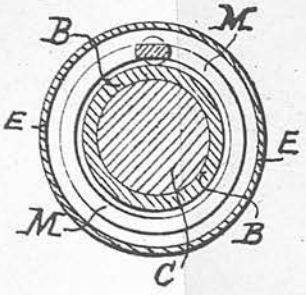
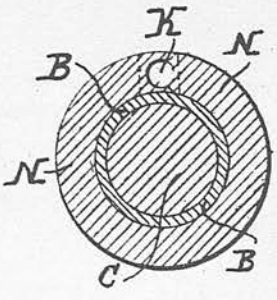


FIG. 4.



Malby & Sons, Photo-Litho.

[Second Edition.]

32.

N° 20,277 A.D. 1910

Date of Application, 31st Aug., 1910

Complete Specification Left, 20th Feb., 1911—Accepted, 18th May, 1911

PROVISIONAL SPECIFICATION.

Improvements in Cooling Arrangements for Internal Combustion Engines on Motor Vehicles.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention relates to cooling arrangements in which there is a fan providing a current of air and a pump providing a flow of water for cooling internal combustion engines on motor vehicles. Hitherto pump and fan have been separate units separately driven, with consequent complication of gearing and increased risk of breakdown.

The invention has for its object the obviation of this and the gain of simplicity and compactness.

According to the invention pump and fan, which each may be of any convenient form, are combined in one unit with their rotatory parts upon a single shaft, driven in any convenient manner from the engine, the whole being carried upon a single bracket adapted to be carried on the engine cylinders or in other convenient position.

In carrying out the invention according to one example, the driving spindle of the unit is carried in bearings, preferably ball, in a hollow sleeve extending from or fixed to the body of a centrifugal pump which in turn bears a flange by which it is fixed within or against the cylinder jacket to which cooling water is supplied.

The spindle extends within the pump body through a usual stuffing box and there carries an impeller of ordinary form. On the opposite end of the spindle is a spider carrying fan blades of usual form and carrying also a cylindrical sleeve extending laterally over the bearing sleeve and having formed upon it a belt-pulley by which the whole is driven from the engine.

Dated this Thirtieth day of August, 1910.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

COMPLETE SPECIFICATION.

Improvements in Cooling Arrangements for Internal Combustion Engines on Motor Vehicles.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to cooling arrangements in which there is a fan providing

a current of air and a pump providing a flow of water for cooling internal combustion engines on motor vehicles, and of the type in which pump and fan, which each may be of any convenient form, are combined in one unit with their rotatory parts upon a single shaft, driven in any convenient manner from the engine, the whole being carried upon a single bracket adapted to be carried on the engine or in other convenient position. The invention has for its object to provide a simple and effective construction embodying these features and characterised by the fact that the pump body is adapted to be connected directly to the cylinder jacket and to deliver thereto and carries a sleeve within which are bearings for the spindle and upon and embracing which is a second sleeve carrying the fan pulley, means of access to the pump packing being provided in the first sleeve or in the pump body.

In order that the invention and the manner of performing the same may be properly understood, there are hereunto appended two sheets of drawings showing a typical arrangement of a pump-and-fan unit carried upon an engine cylinder, Figure 1 Sheet 1 being a sectional side elevation and Figure 2 Sheet 2 a sectional end elevation on the line *a*—*a* of Figure 1.

In this example the driving spindle A of the unit is carried in ball bearings B in a hollow sleeve C. This hollow sleeve C has at its rear a flange C^1 by which it is secured to an annular disc or flange D formed on the ends of webs D^1 (Figure 2) which in turn are formed upon the pump body E.

The pump body E has on it a flange E^1 by which it is secured to an opening in the cylinder jacket E^2 and is provided with an intake G. Practice has shown that the usual vortex collecting chamber for the pump is unnecessary, and the pump rotor H of ordinary form drawing from an axial intake cavity G^1 delivers directly to the jacket space. The pump rotor H is carried on the inner end of the spindle A, and there is provided a usual stuffing box J accessible between the webs D^1 for adjustment or packing. A web with a lubricating aperture J^1 is provided.

On the opposite end of the spindle A is a spider K carrying fan blades K^1 of ordinary form and carrying also a cylindrical sleeve L extending laterally over the bearing sleeve C and externally surfaced for a belt by which it and so the fan-pump unit is driven from the engine.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In a fan-and-pump unit for engine cooling on motor vehicles of the type comprising a spindle carrying at one end a fan and at the other end a pump operative member; a sleeve embracing and having bearings for the spindle and carried on or forming part of the pump body which in turn is adapted to be secured to the engine cylinder, and a driving sleeve pulley for a belt operatively connected to the fan and embracing the bearing sleeve.

2. In the pump-and-fan device forming the subject matter of the foregoing claim hereof, a part on the pump body carrying the bearing sleeve and so formed that it gives access to the usual pump packing device.

3. The fan-and-pump unit for engine cooling on motor vehicles substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Eighteenth day of February, 1911.

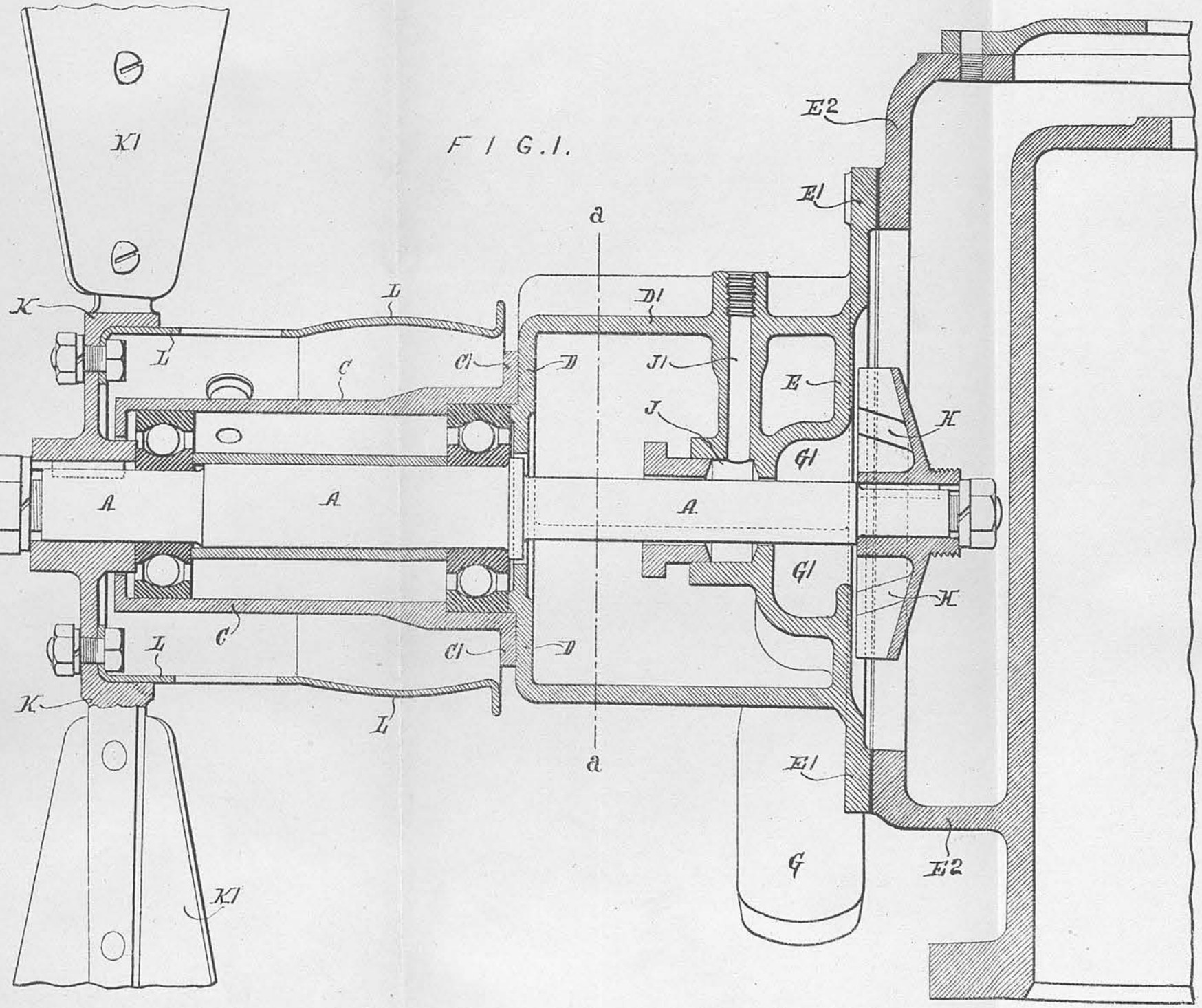
EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 35—50/1/1915.]

(2nd Edition)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

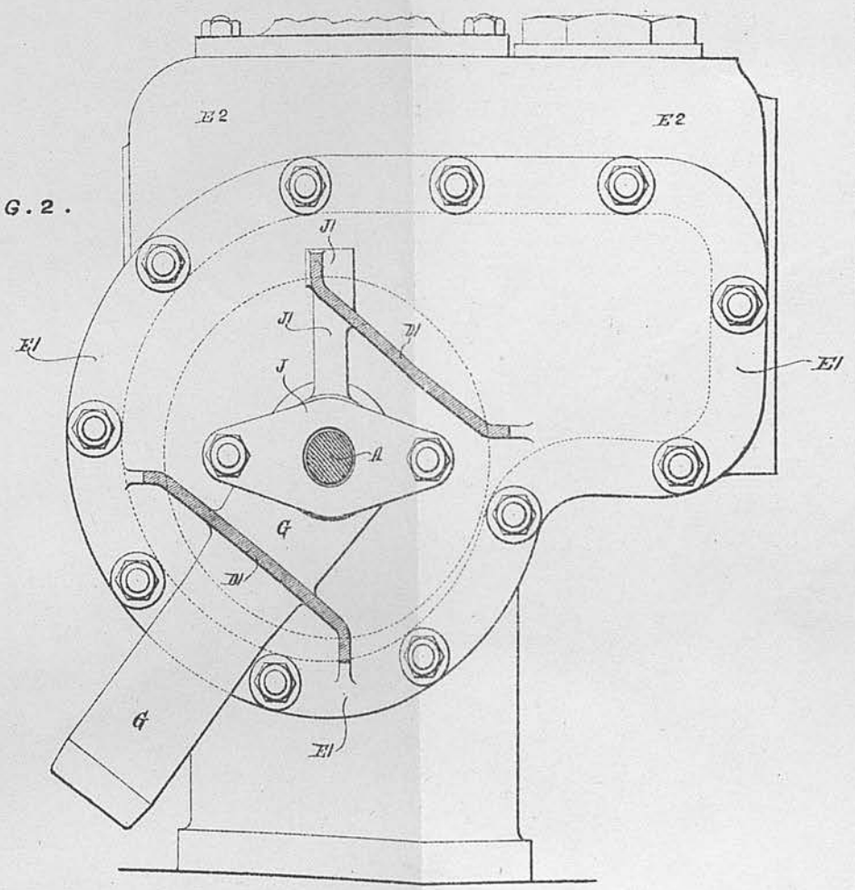


Maloy & Sons, Photo-Litho

(2nd Edition)

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 2.



Malby&Sons, Photo-Litho.

N° 11,878 A.D. 1914

Date of Application, 14th May, 1914

Complete Specification Left, 31st Oct., 1914—Accepted, 29th Apr., 1915

PROVISIONAL SPECIFICATION.

An Improved Friction Drive.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention to be as follows:—

The invention has for its object to provide an improved friction drive which will maintain the speed of the machine to which it is applied constant, irrespective of the variations in the speed of the source of power, and which is unaffected by any external strains such as may arise from a slight lack of alignment between the driving shafts, or from any other cause.

The improved friction drive is thus particularly applicable to small dynamos either of the permanent magnet or self excited type, which are used in a motor vehicle for supplying current to one or two lamps only, and where, as the load is constant, the dynamo must be driven at a constant speed, irrespective of variations in the speed of the motor vehicle engine, from the flywheel or other suitable member of which the drive may be obtained.

In carrying out the invention a driving flange or disc, preferably made of steel, is mounted upon the end of the magneto shaft. This disc is surrounded by a metallic housing of suitable shape which is concentrically mounted on the shaft of the magneto dynamo by ball bearings, which may be of the radial and thrust type combined, or of the radial type alone, so that, apart from the friction device, hereinafter described, no matter what forces are applied to this casing, practically no turning effort can be transmitted from it to the magneto shaft. Mounted internally and concentrically in this casing are one or more friction rings of suitable material, such as vulcanized fibre which has practically a constant co-efficient of friction through a wide range of speed and whose frictional contact at rest is not greatly in excess of the running friction. These rings are prevented by keys, feathers, or the like from rotating relatively to the casing, and are pressed into frictional contact with the steel disc by an arrangement of springs which are preferably adjustable by a screw or screws extending through the casing. The casing is preferably made oil tight and partially filled with lubricant. On its outer periphery this casing may conveniently be fitted with leather rings, or other suitable friction material to receive the drive from the engine fly wheel. Or this casing may be formed as a pulley and driven by a belt, or it may be provided with gear teeth and driven from a gear wheel.

From the foregoing description, it is obvious that by the use of friction rings of such material as have a practically constant co-efficient of friction, a device is provided which transmits under any circumstances only the torque due to the tangential forces arising from the friction due to the pressure between the rings and the disc on the magneto shaft.

Dated this Thirteenth day of May, 1914.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

[*Price 6d.*]

COMPLETE SPECIFICATION.

An Improved Friction Drive.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to that type of friction drive which maintains constant the speed of the machine to which it is applied irrespective of the variations in the speed of the source of power, and in which there is a casing, formed as a pulley, mounted on bearings on the magneto or dynamo shaft, whilst the drive is transmitted from the casing to the magneto or dynamo shaft through friction plates controlled by an adjustable spring, and the invention has for its object to provide an improved form of such drive which is also unaffected by any external strains such as may arise from a slight lack of alignment between the driving shafts, or from any other cause.

The improved friction drive is particularly applicable to small dynamos either of the permanent magnet or self excited type which are used in a motor vehicle for supplying current to one or two lamps only, and where, as the load is constant, the dynamo should be driven at a constant speed, irrespective of variations in the speed of the motor vehicle engine, from the flywheel or other suitable member from which the drive may be obtained.

In carrying out the invention there is provided as in certain known constructions a driving disc or member, preferably made of steel, mounted upon the end of the magneto or dynamo shaft. A casing is mounted on ball bearings on the shaft of the magneto or dynamo, which bearings may be of the combined radial load and thrust type, or of the radial type alone, so that, apart from the friction device, hereinafter described, no matter what forces are applied to this casing, practically no turning effort can be transmitted from it to the magneto shaft. According to the invention there are mounted internally and concentrically in the casing one or more friction rings of suitable material, such as vulcanized fibre—which has practically a constant co-efficient of friction through a wide range of speed, and whose frictional co-efficient at rest is not greatly in excess of the running friction. These rings are prevented by keys, feathers, or the like from rotating relatively to the casing, and are pressed into frictional contact with the steel disc by an arrangement of springs which are preferably adjustable by a screw or screws extending through the casing. The casing may be oil tight and be partially filled with lubricant, but whether or not it is depends upon the character of the material used for the friction discs. On its outer periphery the casing may conveniently be fitted with a driving pulley of leather or other suitable frictional material and of known form to receive the drive from the engine fly wheel. Or the casing may be formed as a pulley and driven by a belt, or it may be provided with gear teeth and driven from a gear wheel.

From the foregoing description, it is obvious that by the use of friction rings of such material as have a practically constant co-efficient of friction, a device is provided which transmits at given speeds of drive under any circumstances only the torque due to the tangential forces arising from the friction due to the pressure between the rings and the disc on the magneto shaft.

In order that the invention and the manner of performing the same may be

properly understood there are hereunto appended a sheet of explanatory drawings in which is shown in Figures 1 and 2, respectively a sectional side elevation and a sectional end elevation (on the line *a*—*a* of Figure 1) of the improved device.

As shown in the drawings, a driving disc or member A, preferably of steel, is mounted on the end of the dynamo shaft B. A casing made in two parts C, D is mounted on ball bearings E on the shaft B. One part C of the casing serves as a housing for the outer race of the ball bearings which are retained in place in it by a cover plate F, and has formed also a V-groove G for a driving belt. The other part D of the casing serves to carry a disc H surfaced with frictional material and guided on feathers J in the part D. Between this disc H and a carrier K having a screwed stem L engaging an aperture in the casing part D is a spring N pressing the disc H into contact with the disc A. A nut M serves to lock the stem L when it has been adjusted.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a friction drive device of the type described having a driving disc or member on the spindle of the dynamo or magneto and a casing mounted on ball bearings on said shaft; a second member rotated with the casing but capable of endwise movement, and an adjustable spring device forcing the two members into frictional contact, as described.

—2— The improved driving devices substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Thirtieth day of October, 1914.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.

FIG. 1.

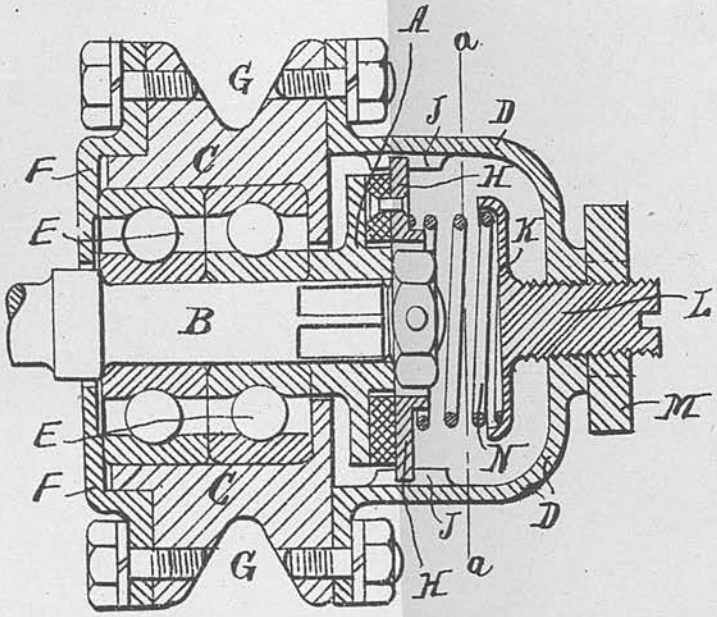
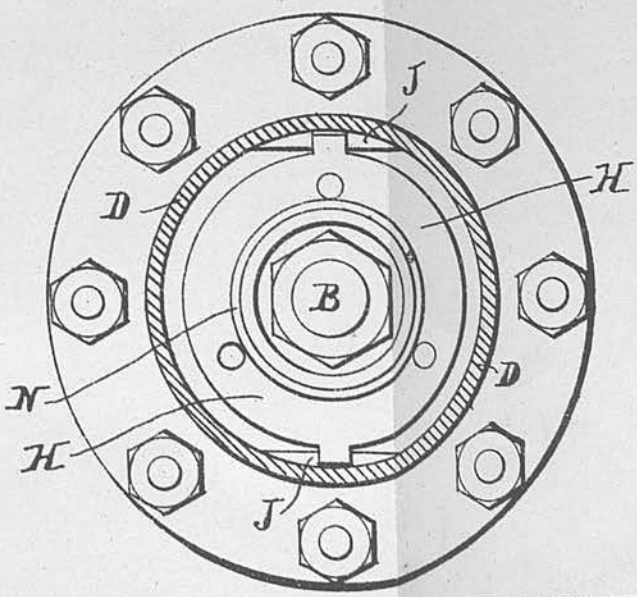


FIG. 2.



Malby&Sons, Photo-Litho.

34.

N° 2800 A.D. 1915

Date of Application, 22nd Feb., 1915—Accepted, 3rd June, 1915

COMPLETE SPECIFICATION.

An Improved Friction Drive.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to that class of friction drive more usually applied in the driving of small dynamos at a substantially constant speed from a prime mover of varying speed, and in which the contact between the frictional surfaces is unaffected by external strains due to side pressure exerted again the friction or belt pulley by the wheel or belt engaging it, but which frictional contact is modified by a centrifugal governor acting upon the spring which presses the friction surfaces together.

Since the coefficient of the friction of rest is usually greater than the coefficient of the friction of motion, it follows that in such devices there is a certain tendency for hunting to take place. That is to say, upon a rise in speed of the prime-mover, the friction device will drive without slip until a higher speed of the driven shaft is reached than could be maintained were the surfaces slipping, and once slip does take place there is therefore a sudden drop in the speed of the driven shaft.

The invention has for its object to overcome this disability, and according to it, while the governor is arranged in known manner to remove from the friction surfaces a member urged by a spring to press them together, there is arranged between this member and the friction surfaced member a secondary spring.

On two accompanying sheets of explanatory drawings there are shown two illustrative examples of the carrying out of the invention, Figures 1 and 2, Sheet 1 being respectively an end and a sectional side elevation of an example in which the primary drive is by friction pulley, and Figures 3 and 4, Sheet 2, like views of an example in which the drive is by belt pulley.

In the example shown in Figures 1 and 2, a friction pulley A is mounted upon ball bearings B on the driven shaft C, the ball bearings being such as to take up any small end-thrust and prevent its affecting the engagement of the frictional surfaces forming the driving connection between the pulley and the shaft. With a face D on this pulley, there contacts a disc E of frictional material carried on a sleeve F free to slide on the shaft C and having on it a flange G engaging the friction disc E. On the sleeve F is a second sleeve H having a similar flange J and a muff part K. Between the flanges G, J is a device consisting of two blade springs L riveted to the one flange and having pegs M engaging apertures in the other. Thus the two sleeves are constrained to turn together. Screwed and pinned upon the shaft C is a spider N on which are pivoted centrifugal weights O, arms on which engage the muff part K. The sleeve H has parts removed at its sides so that it extends between and is engaged by the arms of the spider N—thus the spider fast on the shaft C is constrained to rotate with the sleeves F, H which are driven by the friction

disc E. Frictional contact is provided by a spring P arranged in compression between the sleeve H and a nut and lock nut R on the end of the spindle C.

In operation at normal speeds the spring P acts to cause engagement of the frictional surfaces D, E, but upon the determinate speed being approached, the governor weights O exert a pressure upon the sleeve H opposing that of the spring P and thus relieving the pressure upon the frictional surfaces so that slip there takes place, speed falls, and the governor acts less strongly until a balance assisted by the springs L is arrived at.

The example shown in Figures 3 and 4 only differs from that described in that the pulley A is grooved for a belt, and there are provided forks S capable of engaging the flange G enlarged for this purpose. The forks S are mounted upon a spindle T rotatable by any convenient means to engage them with the flange G and so throw the frictional device out of engagement.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a friction drive device comprising frictional engaging surfaces so arranged that their engagement is substantially unaffected by external forces, and having frictional surfaced members urged into contact by a spring-urged member under the control of a governor; a subsidiary spring between the spring-urged member and one of the frictional members as set forth.

—2— In combination with the subject-matter of the foregoing claim hereof, means for manually moving the frictionally engaging members out of contact.

—3— The improved friction drive devices substantially as hereinbefore described with reference to Figures 1 and 2 and to Figures 3 and 4 respectively of the accompanying drawings.

Dated this Twentieth day of February, 1915.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.

SHEET 1.

FIG. 1.

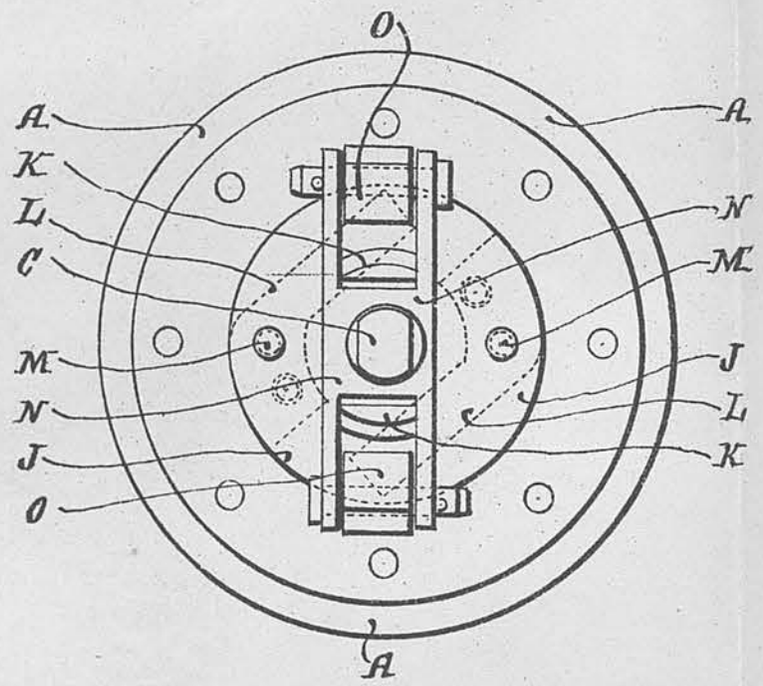
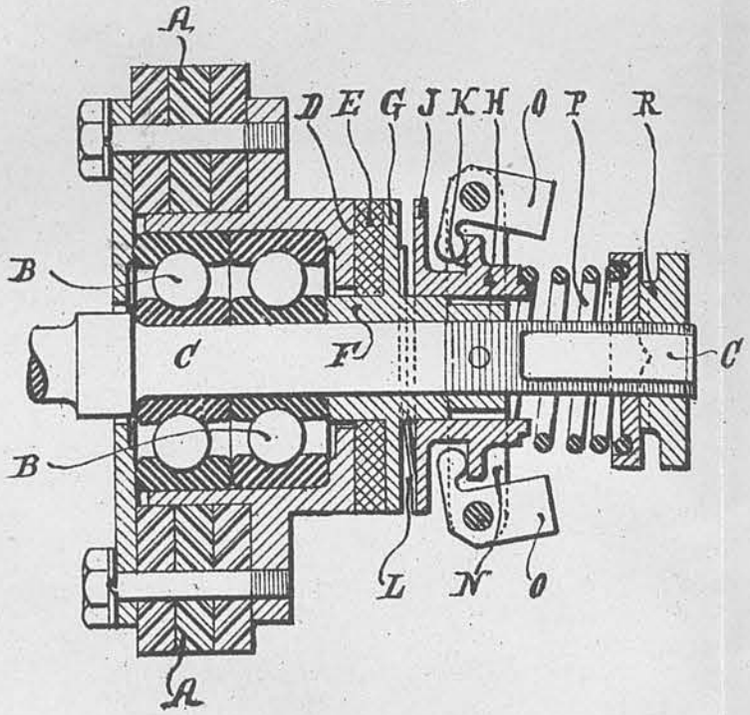


FIG. 2.



SHEET 2.

FIG. 3.

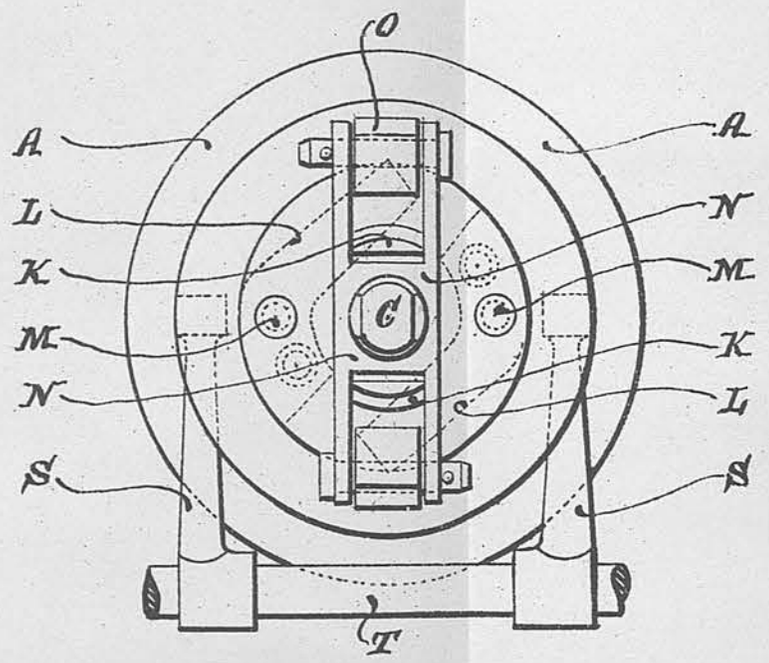
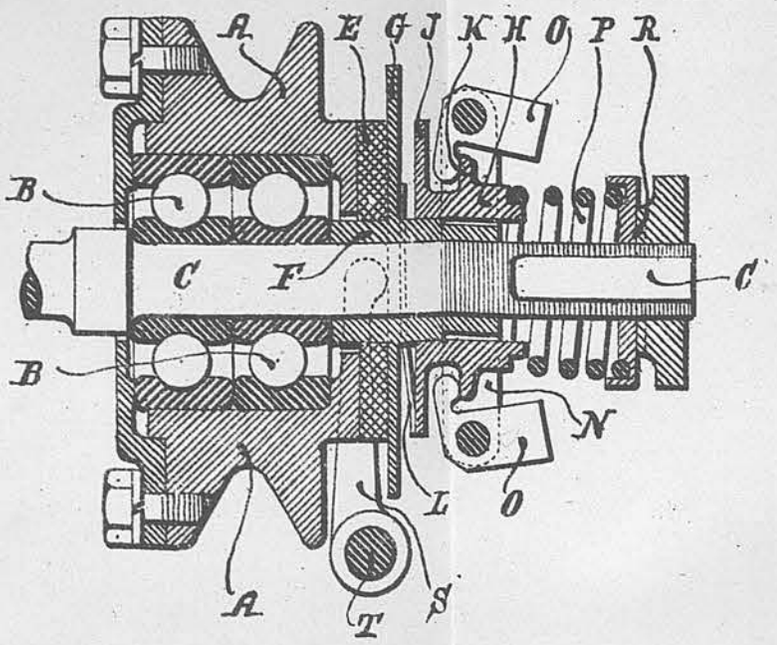


FIG. 4.



Malby & Sons, Photo-Litho

35.

N° 11,139 A.D. 1915

Date of Application, 31st July, 1915—Accepted, 14th Oct., 1915

COMPLETE SPECIFICATION.

A Switch Device for Car-lighting and like Dynamos.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

When a car-lighting or like dynamo is driven from the vehicle engine through the medium of a friction device of the kind so controlled as to its slip that the speed of the dynamo when under load cannot exceed a determinate maximum, it, the dynamo, may when unloaded obviously exceed that speed. Thus, were the load suddenly thrown upon the dynamo at such a time, the current produced would be momentarily of abnormally high voltage, with the result that the filaments of the lamps constituting the load might be damaged or broken.

The invention has for its object, by the provision in the dynamo circuit of a simple three-way switch, to obviate this disability and avoid also the complication of a mechanical device for the same object and by which the dynamo may be thrown out of engagement with its driving device.

According to the invention, in the first position of the switch the dynamo circuit is broken, and then runs light and possibly at excessive speed. In the second position of the switch, the dynamo is short circuited directly or through a resistance, thus loading it and bringing down its speed. In the third position of the switch, the lamp (or lamps) is brought into circuit. In order that the third position may not be reached too rapidly so abrogating the speed reducing qualities of the short circuiting, there is provided in the mechanism for operating the switch a retarding device which may for example be in the form of a handle or key, several successive movements of which are required to complete the movement of the switch, or of a train of reducing gearing operated by a crank handle, or of a dashpot device interposed between the switch and its operating means in suchwise that the dashpot limits the speed at which the switch may be moved.

On two accompanying sheets of drawings are shown diagrams of the circuit arrangement and views of two examples of switch control. Figure 1, Sheet 1, is a circuit diagram, and Figures 2, 3, and 4, respectively a sectional elevation, a plan, and an inverted plan of one example of switch, while Figures 5 and 6, Sheet 2, are a front and a sectional side elevation of a second example of switch, Figure 7 being a diagram of an alternative circuit arrangement.

In the diagram shown in Figure 1, the arm A of the three point switch shown in its off position is connected to the lead B. The first contact piece C of the switch is connected to the lead D, either directly as shown, or through a resistance. The second contact piece E closes the dynamo circuit through a lamp F.

In order to control the passage of the switch arm A from the contact C to the contact E, a retarding device, such for example as that shown in Figures 2, 3, and 4, is preferably provided. In this example the switch arm A, pivoted on a base G and moving over contact pieces C, E fixed to that base, has on it a

[*Price* 6*d*.]

detent plate H having in it apertures J and a series of ratchet teeth K. The ratchet teeth are engaged by a spring controlled pawl L pivoted on the base and having a releasing push device M extending through the switch cover N. The detent plate H and switch arm A are operated by means of a pin P on an arm R operating between stops S in the cover N and carried on a spring controlled spindle T provided with a turn-button U. The switch arm A is normally brought to "off" position by a spring V. It may be moved from that position relatively slowly by pressing the turn-button U and so causing the pin P to engage one of the apertures J in the plate L, then turning it. The plate is thus rotated, and when rotated is retained by the pawl L. The button is then released, turned back, and the next aperture J engaged, and so on, until the switch movement is complete. Pressure on the push piece M releases the switch, whereupon the spring V returns it to the "off" position.

In Figures 5 and 6 is shown a second form of retarding device. On the arm A is a toothed sector W with which there engages a small pinion X on a spindle Y terminating in a crank handle Z. A spring X^1 is so arranged between the sector and the base that the arm A tends to be held either against the stop X^2 or the stop X^3—that is to say either in "off" or "on" position. The device is of course operated by turning the crank handle Z—necessarily a slow movement as regards the arm A.

The circuit diagram shown in Figure 7 only differs from that shown in Figure 1 in the manner in which the two contact pieces are arranged, the first C^1 of these being long, the second E^1 being short. The first position of the switch arm A is that shown—the dynamo circuit is broken. In the second position, the arm lies on both contacts, and E^1 being earthed the dynamo is short circuited—a resistance less than that of the lamp may be interposed. In the third position the arm A has left the contact E^1 but remains on the contact C^1 and the lamp F is brought into circuit.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

—1— In a car-lighting or like dynamo arrangement, a three way switch the first position of which breaks the dynamo circuit, the second short circuits it (it may be, through a resistance) and the third throws into circuit with the dynamo a lamp or lamps, in combination with means for controlling the speed of operation of the switch.

—2— In the device forming the subject-matter of the foregoing claim hereof, means for operating the switch in limited successive steps as set forth.

—3— In the device forming the subject-matter of Claim 1 hereof, a speed-reducing train between the switch operating handle and the switch, for the purposes set forth.

—4— In the device forming the subject-matter of Claim 1 hereof, a dashpot device so interposed between the switch and its means of operation that a predetermined speed of onward-movement of the former cannot be exceeded.

—5— The improved arrangements and devices for car-lighting and like dynamos substantially as hereinbefore described with reference respectively to Figure 1, to Figures 2, 3, and 4, to Figures 5 and 6, and to Figure 7 of the accompanying drawings.

Dated this Thirtieth day of July, 1915.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1915.

A.D. 1915. JULY 31. No. 11,139.
ALBION MOTOR CAR CO. & *another's* COMPLETE SPECIFICATION.

FIG. 1.

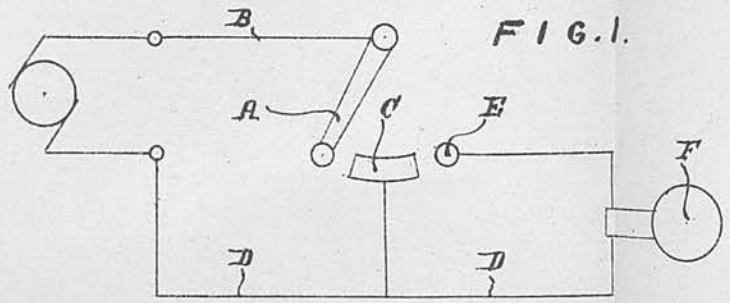


FIG. 2.

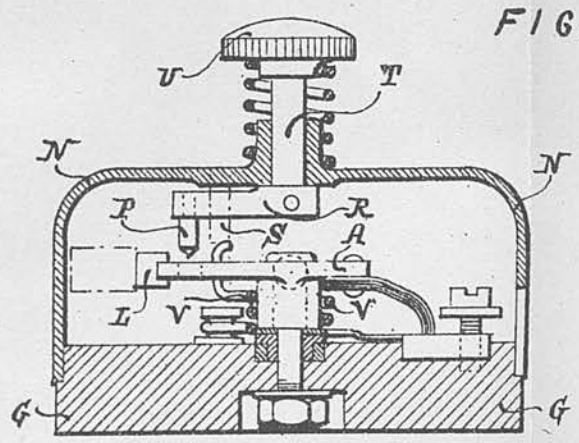


FIG. 3.

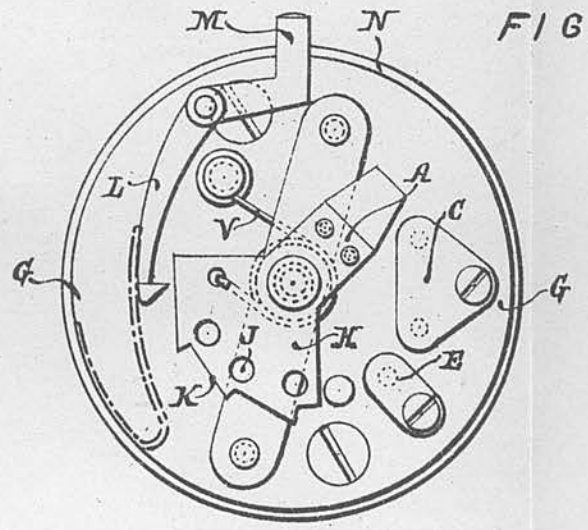


FIG. 4.

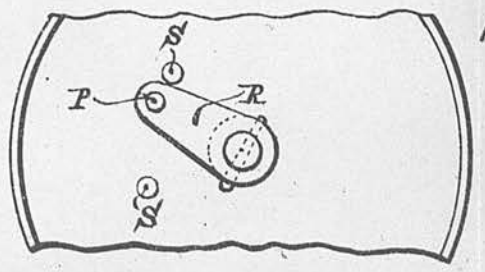


FIG. 5.

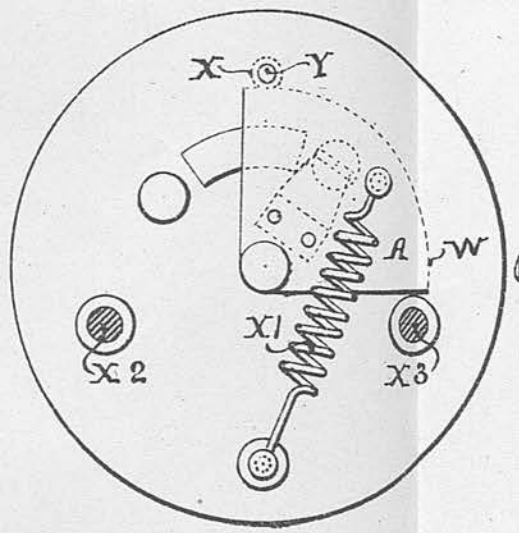


FIG. 6.

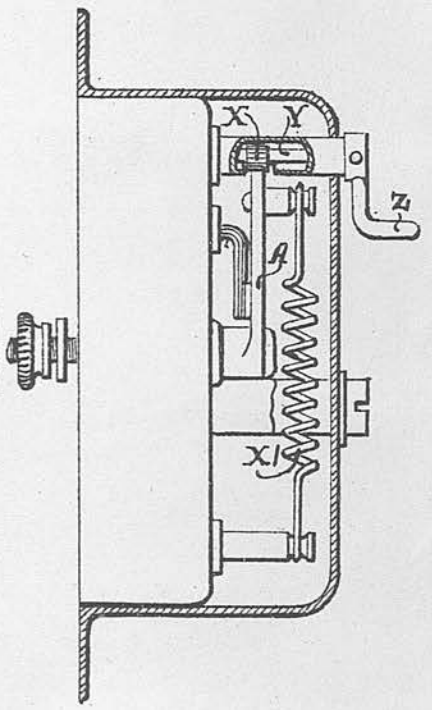
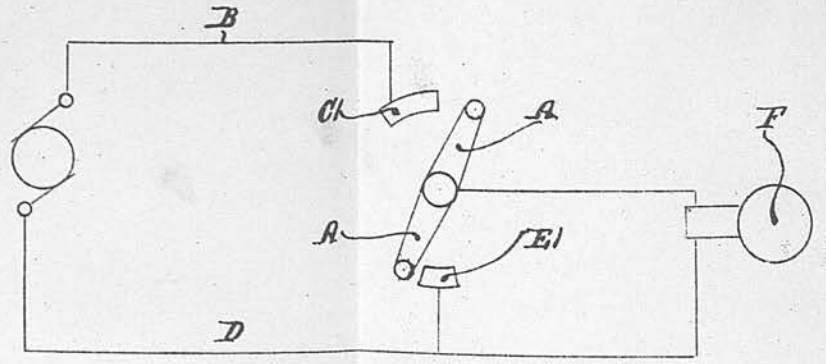


FIG. 7.



Malby&Sons, Photo-Litho.

36.

101,243

PATENT SPECIFICATION

Application Date, Mar. 10, 1916. No. 3559/16.
Complete Accepted, Aug. 31, 1916.

COMPLETE SPECIFICATION.

Improvements in connection with Electric Car-lighting Equipments.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., M.Inst.C.E., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to that simple type of car-lighting equipment in which a shunt-wound dynamo driven from the engine through a speed-limiting device such as the pulley described in the Specification of our prior Patent No. 2800 of 1915 is directly connected to a lamp or lamps—no storage battery being used. The invention has for its object to diminish wear and tear by arranging that no current shall be generated when the lamp (or lamps) is not in use.

According to the invention the usual switch controlling the lamp circuit controls also the field circuit of the dynamo—that is to say, it is arranged in the circuit of one of the dynamo brushes.

An accompanying diagram illustrates this arrangement, a single-circuit switch A of any convenient form being arranged in the circuit of the brush B and so controlling the excitation of the field coil C at the same time as it controls the lighting of the lamp D. Thus, when the switch is open and the lamp not in use, the dynamo field is not excited, and the armature spins idly without generating current.

Having now particularly described and ascertaind the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

In a car-lighting equipment of the type described, a single-circuit switch directly in the circuit of one of the dynamo brushes and controlling not only the lighting of a lamp or lamps but also the excitation of the dynamo field as and for the purposes set forth.

Dated this Ninth day of March, 1916.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
Applicants' Agents.

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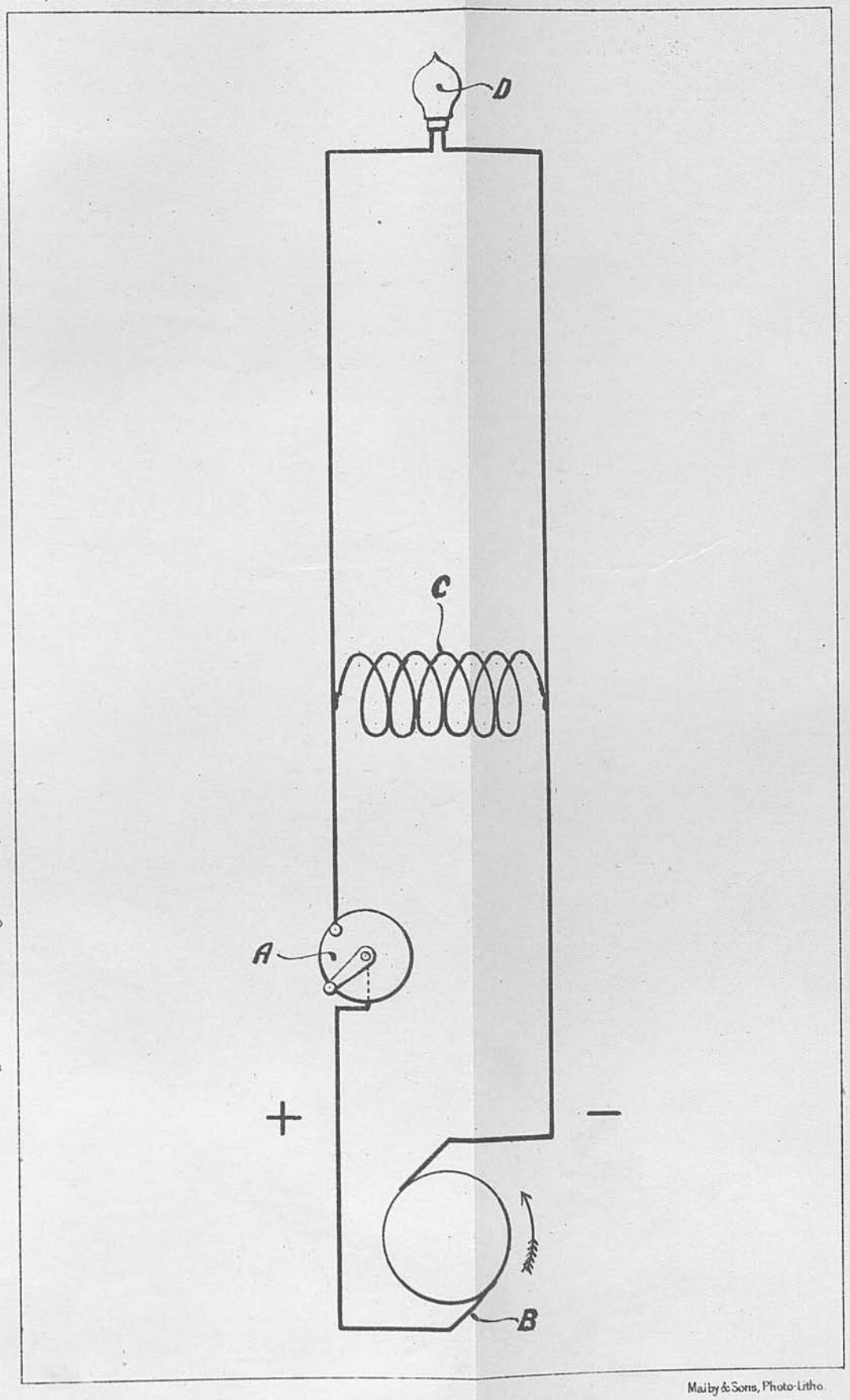

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PATENT SPECIFICATION

Application Date, July 3, 1916. No. 9293/16.

Complete Accepted, Nov. 16, 1916.

COMPLETE SPECIFICATION.

A Governor Arrangement for Internal Combustion Engines.

We, ALBION MOTOR CAR COMPANY, LIMITED, of South Street, Scotstoun, in the County of Renfrew, North Britain, and THOMAS BLACKWOOD MURRAY, B.Sc., M.Inst.C.E., of the same address, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention has for its object to provide for internal combustion engines for motor vehicles a neat compact and entirely enclosed governor arrangement and one which cannot be tampered with by the driver.

According to the invention the governor which may be of any convenient type is arranged on the idle end of the crank shaft and within the crank casing. Its muff is connected by a lever or link with a longitudinal member endwise movable arranged within the crank-case and extending to a position immediately beneath the usual induction pipe. A vertical member arranged within a hollow-pillar extending between the crank-case top and the induction pipe is operatively connected to the longitudinal member and operates a throttle valve preferably of butterfly form in the induction pipe.

A spring acting upon the throttle valve to tend to shut it is provided, this spring being of lesser intensity than the usual governor spring, so that until centrifugal action takes place in the latter the throttle valve remains open. A certain amount of idle movement is provided in the connections, so that should the movement of the governor due to excessive engine speed be excessive the throttle valve shall not be strained or damaged.

An example of the improved arrangement is shown as applied to an engine of well-known type in sectional plan in Figure 1, Sheet 1, and in sectional side elevation in Figure 2, Sheet 2 of two accompanying sheets of explanatory drawings.

In this arrangement the centrifugal governor A of well-known "monkey" type is arranged on the idle or forward end of the crank shaft B, the moment of its weights C being opposed by a spring D. The usual endwise movable muff E is engaged by a block pivoted on a lever F, which lever is pivoted on an arm G secured in the crank case H. To the opposite end of this lever F there is coupled by an adjustable connection J the longitudinal member which consists of a rod K lying within the crank-case passing through the usual transverse bulkhead L therein and guided at its rear end in an aperture in a stud M.

On the rod K is a jaw-piece N which engages with a certain amount of lost motion (for the purpose already set forth) a pin O on a lever P fast on a

[*Price 6d.*]

vertical rod Q which carries at its upper end a butterfly throttle valve R in the induction pipe S. This rod passes up through a hollow pillar T secured to the top of the crank-case H and forming at its upper end part of the induction pipe S. A coil spring V arranged about the rod Q tends to close the throttle valve.

It will be seen that in the improved arrangement the parts are entirely enclosed and inaccessible to the driver. As a further precaution, the bolts and so forth holding parts such as the hollow pillar T may be sealed.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

—1— A governor arrangement for internal combustion engines comprising a governor of known form on the idle end of the crank shaft, a lever or link connecting the governor muff to a longitudinal member within the crank case, a vertical member operatively connected to the longitudinal member and operating an induction pipe throttle-valve, there being a certain amount of idle motion in the connection, and a hollow pillar extending between the induction pipe and the top of the crank chamber.

—2— In the arrangement forming the subject-matter of the foregoing claim hereof a spring of lesser intensity than the governor spring and tending to close the throttle valve.

—3— The improved governor arrangement substantially as hereinbefore described with reference to the accompanying drawings.

Dated this Thirtieth day of June, 1916.

EDMUND HUNT & Co.,
Chartered Patent Agents,
121, West George Street, Glasgow,
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FIG. 1.

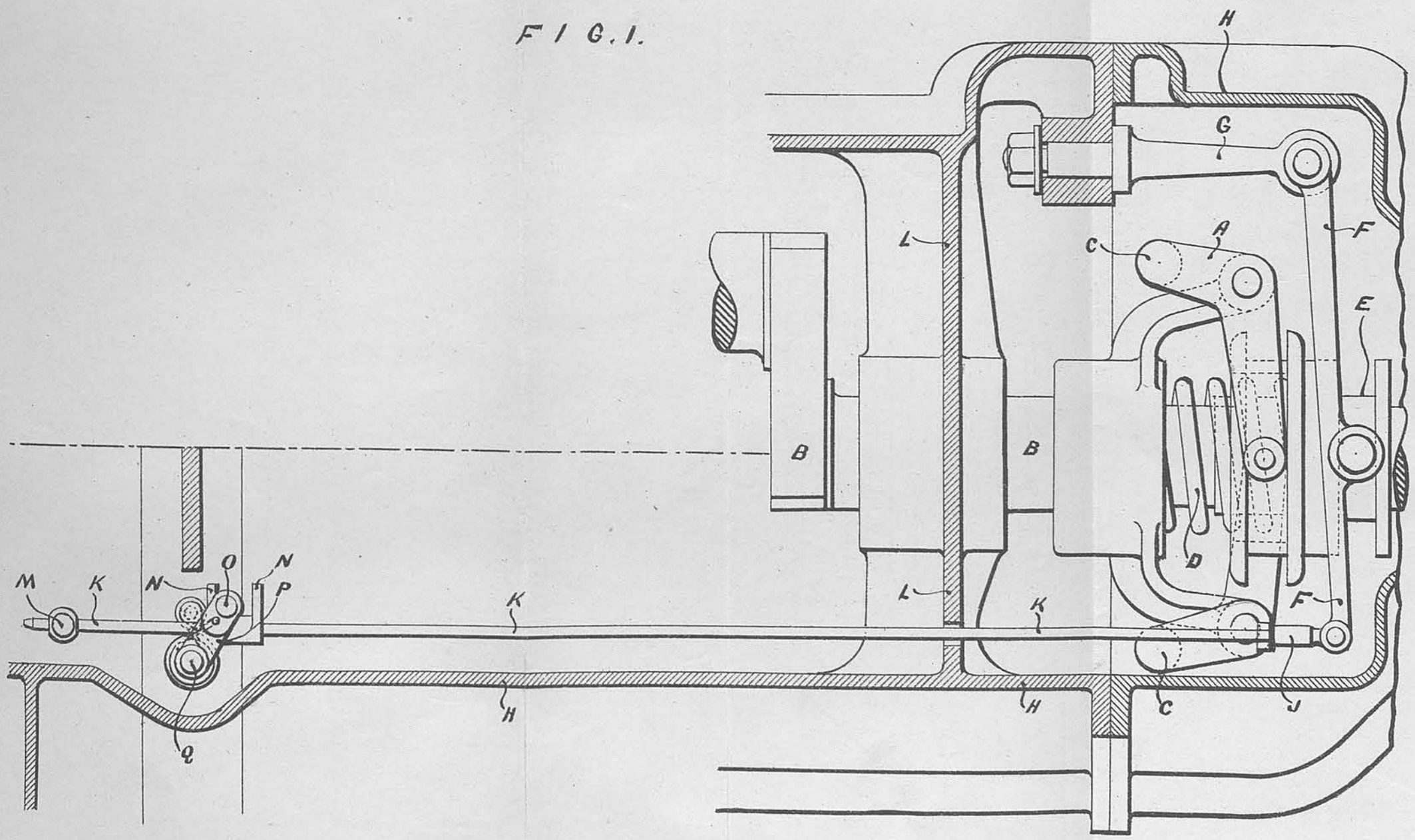

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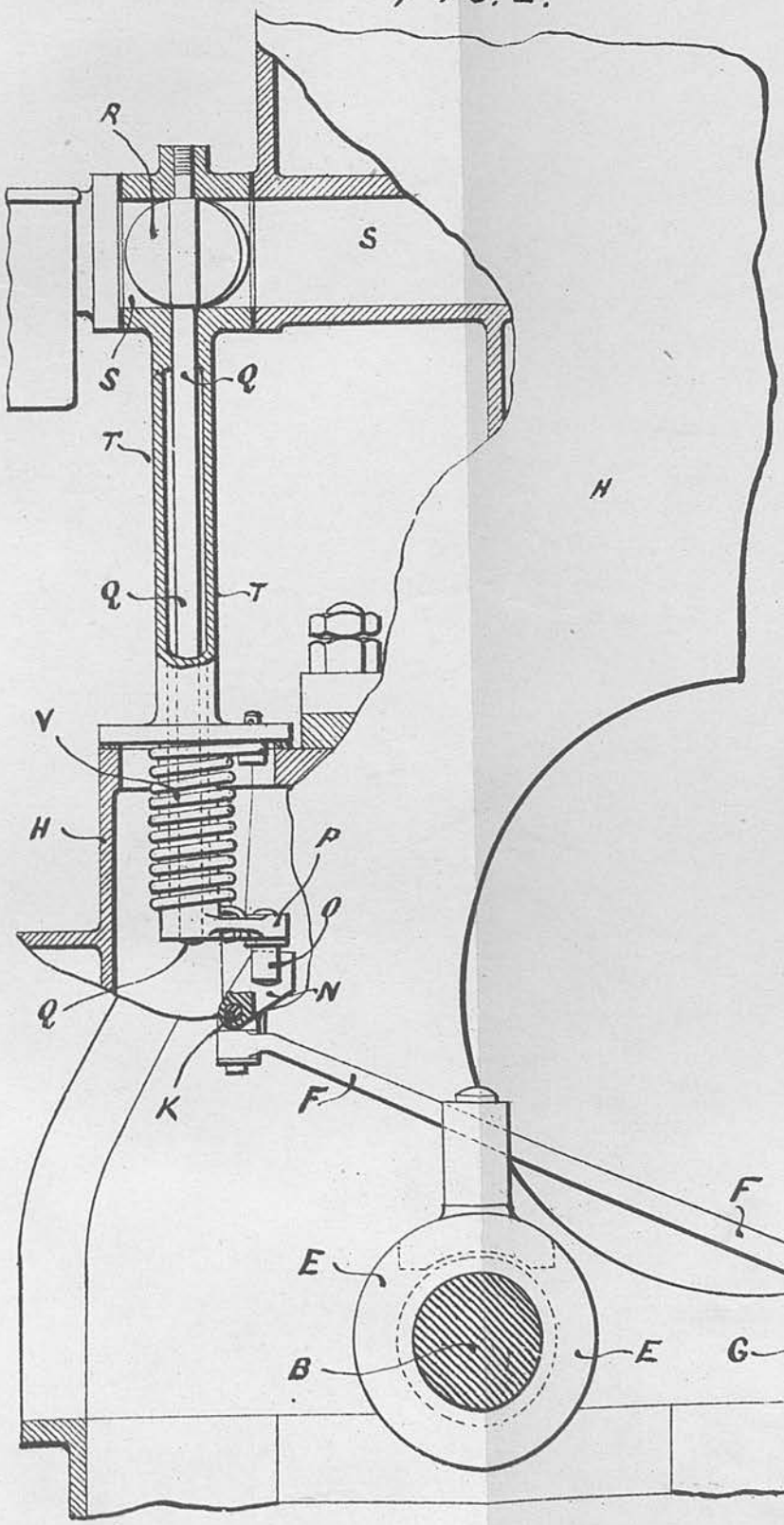
FIG. 2.



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